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COLLECTIVE BARGAINING FOR MEDICAL CARE BENEFITS: A RECENT DEVELOPMENT IN THE U.S.A.

BY

T. PARRAN and L. FALK

From the Graduate School of Public Health, University of Pittsburgh, Pennsylvania, U.S.A.

1. General

Collective bargaining between trade unions and employers for health and welfare benefits has been perhaps the most striking recent development in the organization of medical service in the United States of America. The sudden burgeoning of plans resulting from such activity has out-distanced studies of them. However, it is known that by mid-1950 more than 7·6 million workers in practically every major trade union and a large number of their dependents were covered to a greater or less degree by such plans (Rowe, 1951; Brannon and Breher, 1951). A decade ago the number had been in the thousands.

Industrial medical care plans of many types and of diverse quality had an early origin in the United States, (Klem, McKiever, and Lear, 1950; Williams (1951). The Federal Marine Hospital Service (1789), which was created by a check-off from the wages of merchant seamen, followed the earlier English pattern of providing medical care for coal-heavers on the Thames. As this part of the western hemisphere was developed, mining and timber operations, railways, and other new industries starting in virgin soil found it necessary to provide some type of medical care through a wide variety of patterns to meet their diverse needs. Usually the unorganized workers had little or no voice in either the form or the pattern of these services, yet they paid the bills in one way or another.

But formal trade union collective bargaining for medical care benefits has been almost entirely a development of the last decade.

By 1949 they had become the primary issue on the collective bargaining agenda for many unions, particularly those in the basic industries (Becker, 1951).

The bitter strikes in the steel and coal industries in 1949 revolved largely around that issue. By 1953, practically all the members of large trade unions had at least partial indemnity for hospital and surgical expenses, all through some such agreement.

The currently developing labour-employer agreements on health and welfare benefits interact with all other trends in the field of health and welfare, and can be expected to modify future governmental medical programmes. (This point is elaborated below.) The development has been so sudden that even the keen-sighted and intensive review, "American Medical Services", published in this Journal 5 years ago makes no mention of it (McKeown, 1948).

Prerequisites.—Some prerequisites for the development of the employer-employee medical care plans which we are discussing can be considered to have been:

(1) The increase in trade union membership in the United States during the 1930s and '40s to some 15 million workers. This was helped by the provisions of the Wagner Labour Act of 1933, which fostered and protected collective bargaining.

(2) Technological developments in the field of medical care. One such development was the use of group insurance in non-profit and commercial private medical care insurance. This had much to do with the creation and development of Blue Cross and Blue Shield, and of commercial hospital and surgical expense indemnity. Other factors were the growth of medical group practice, the increased understanding of the importance of preventive medicine, and the increased capabilities and the resulting public prestige of medicine because of scientific advances in therapy.

(3) The failure of the Congress to enact a national health insurance programme, as proposed for more than a decade in successive Wagner-Murray-Dingell bills and their successors. These proposed National Health Acts represented labour's first choice of method for medical care payment.

Chronology.—The specific catalyst was the "wage freeze" during World War II developed to help prevent inflation, and the concomitant National War Labour Board policy formulated in 1942 to approve as non-inflationary "Sickness Benefit" programmes not exceeding 5 per cent. of payroll.

The cost of such benefits could be deducted by corporations as business expenses, and this proved especially attractive in view of the high excess profits

taxes; corporations with substantial excess profits could provide health benefits as a tax-deductible item with little actual expense, since they would have had in any case to have paid much of it out in taxes. Most of the programmes were therefore totally, or primarily, employer-financed in lieu of wage increases (Becker, 1951).

By 1945, the Department of Labour, having searched the 12,000 union agreements in its files, found that about 600,000 workers were covered by health benefit plans established through collective bargaining (Peterson, Kassalow, and Nelson, 1945). The next year almost as many workers again, and all their dependents, were brought into coverage by an agreement creating the United Mine Workers of America Welfare and Retirement Fund. This important development is dealt with separately at some length below.

In 1949, the United Steelworkers and the United Automobile Workers, both of the C.I.O., and with membership of about two million, signed wage agreements which included nation-wide hospitalization and surgical service insurance based upon company and membership contributions.

Some American Federation of Labour unions, such as the International Ladies Garment Workers' Union, had earlier been in the forefront of the development, and other unaffiliated unions did not lag behind.

PATTERN.—"Group Insurance", covering a range of benefits developed as "package plans". Most workers were covered by pension, hospitalization, surgical indemnity, disability indemnity, and a modest life insurance allocation. These supplemented the Old Age and Survivor's Insurance payments under the Social Security Act. Some indication of the extent of these employer-employee plans is given in the Table.

It should be noted that in the Table the rows numbered 2, 3, and 6 deal with medical service. Hospitalization and surgical indemnity were commonly covered, but "comprehensive" medical care *i.e.* including also physician office and home calls, was only infrequently covered. The most common medical benefits were hospital and surgical (including obstetrical) coverage. Commercial insurance and Blue Cross were most commonly used, rather than the industries or unions providing their own services directly. Most of the sickness benefits and wage-loss indemnity start after a waiting period of one week in the event of illness, but from the first day in the event of an accident, the duration of both is commonly limited to 6 months. Invalidity indemnity (for disability of over 6 months) is not covered.

TABLE

HEALTH AND WELFARE UNDER COLLECTIVE BARGAINING, 1950

Based on the plans of 140 unions with 4·3 million workers

Type of Benefit Provided	Plan Members Covered by each Benefit		
	Number (millions)	Per cent.	Employer-financed (Per cent.)
1. Life insurance or death benefit	4·2	96	67
2. Hospitalization	3·5	80	65
3. Surgical and/or Limited medical care*	3·1	72	72
4. Sickness wage-loss compensation	2·8	64	59
5. Accidental death and dismemberment	2·0	46	70
6. "Comprehensive" medical care†	0·4	10	no data

* "Limited medical care" ordinarily refers to in-hospital physician visits or consultations.

† Includes at least physician and surgeon service in the office, home, or hospital, and coverage of hospital bills.

In 1952 total disability payments were authorized by Federal law as a *public assistance* "Aid to the Disabled Worker", but were specifically rejected as a *social insurance* category. Thus the United States continues to follow the tradition of the Elizabethan Poor Law, rather than the recent British national insurance legislation.

SOURCES OF FINANCE AND DEPENDENTS' COVERAGE.—In the coverage reported in the Table, sole support by the employer accounted for 55 per cent. of the health and welfare plans, 37 per cent. being contributed to jointly or solely financed by the employee, and 9 per cent. undetermined. Dependents were automatically covered in only 20 per cent. of the agreements in this sample; in another 50 per cent. extra payment of premiums would include the dependents, but not ordinarily for the same full benefits as those received by the worker himself. The employer-financed plans were characteristic of the textile, apparel, leather, lumber, furniture, mining, printing, insurance, and finance industries. Employee contributory plans were dominant in the paper, petroleum, chemical, rubber, metal products, stone, and clay industries. The two patterns seem to be due primarily to differences in trade union strength. The findings of a nation-wide survey were published by the Research Council for Economic Security (1950).

COMPLEXITY.—The intricacy of the present pattern is revealed by an exhaustive survey made in 1950, in the San Francisco, California, Bay Area, where plans of the many American Federation of Labour (A.F. of L.) affiliates were studied (Weinerman, 1952). Over half of the 200,000 trade union members were covered by collective bargaining health and welfare

agreements. Among 71 local unions, 64 separate plans existed, with 24 different insurance carriers, administered from 45 different union, employer, insurance carrier, broker, or special fund offices. The Garage and Service Station Employees alone had five *separate* welfare funds.

San Francisco is not unusual in this respect. It is only unusual in the fact that there the problem has been thoroughly studied. We in the U.S.A.—in our medical care plans—seem on the record to be trying to "muddle through".

2. United Mine Workers of America Welfare and Retirement Fund*

In May, 1946, the U.M.W. created its "Welfare and Retirement Fund". Back of it was the philosophy of that union: the "human costs of production" must be borne by the industry which necessitates or creates them. It is perhaps the most unique and ambitious of the many labour-union sponsored employee benefit programmes.

The coal-miners felt keenly the need for such a fund for many reasons, the most persuasive one being the hazards of the occupation. Even to-day, one out of every seven coal-miners in the U.S.A. suffers a lost-time accident each year. Among the coal-miners currently employed, seven are killed each working day; each year two out of every thousand active coal-miners are killed at work.

Over the decades the question of *State* versus *Federal* responsibility for safety and other provisions for the miners has been debated. After the Federal Government took over nominal responsibility for operating all of the coal mines in 1944, Admiral Ben Moreell as Administrator called upon his medical colleague, Admiral Joel Boone, to make a survey of medical, health, sanitation, and living conditions among the 400,000 workers engaged in this vital industry.

The now well-known report which followed an exhaustive governmental survey (Boone, 1947), helped to spotlight the appallingly bad medical and hospital services in the coal-mining "patches" (communities). It also described the miserable environmental sanitation, housing, and recreation, and the lack of public health services. The report helped to document the widely-held opinion that conditions would have to change for the better if the workers in this industry were to survive and produce the needed commodity.

The Mine Workers' Fund began its medical work with paraplegic miners. Paraplegia is a common work-connected accident in the coal industry, due to rock falls "jack-knifing" the miner, fracturing vertebrae, and severing the spinal cord. The newly-developing physical rehabilitation techniques were transposed from the Veterans and Armed Forces hospitals into civilian life and were developed under the impact of this programme, which helped to create many of the first civilian rehabilitation centres in the U.S.A. Another special centre was set up for miners suffering from silicosis.

Starting at a five cent per ton "royalty" for the Welfare and Retirement Fund, 40 cents is now being paid into the Fund on each ton of coal mined. The Fund is a non-profit-making charitable trust, administered by a tripartite Board of Trustees* which administers an extensive general medical care programme (U.M.W.A. Welfare Fund Report, 1952) under the direction of a distinguished public health administrator (Dr. Warren F. Draper). The following medical services are now being provided from the "royalty payments":

(1) Hospitalization and in-hospital physician care, paid for in "participating" existing hospitals, for care by "participating" individual physicians or medical groups. Up to the present, a wide free-choice, fee-for-service approach has been taken, the Fund arriving at its own agreements with hospitals and physicians or medical groups. Nursing (convalescent) home care is paid for *in lieu* of hospitalization when it represents a necessary but less expensive active medical management of the case. Custodial care is excluded. Special-duty nursing, when medically indicated, is paid for.

(2) Specialist office service and hospital out-patient service in participating hospitals by participating physicians.

(3) Certain specifically listed drugs in certain chronic diseases, selected as likely to be expensive and needed for prolonged use, as well as in-hospital drugs arising from (1) above. Examples are: insulin for diabetes, liver and vitamin B-12 for pernicious anaemia, and streptomycin for tuberculosis.

The programme includes not only the working miner but also his wife and dependent children (including disabled adult children), and other actual adult dependents living under his roof for over 6 months. Unemployed, disabled, retired, and pensioned miners and their dependents, and the widows and orphans of miners are also eligible unless they have forsaken employment in the bituminous coal industry.

* Part of this section is adapted from a paper presented to the "Conference on Current Problems in Administrative Medicine" sponsored by the Institute of Administrative Medicine, Columbia University, New York, 1952.

* At present composed of Mr. John L. Lewis, President of the United Mine Workers of America (Chairman), Mr. Charles Owen, Bituminous Coal Operator Trustee, and Miss Josephine Roche, neutral Trustee and full-time Director of the Fund.

A case-finding approach is maintained, as is the "service" medical economic approach, *i.e.* the entire amount of a reasonable bill for services within the scope of the programme is paid for by the fund without extra payment by the members.

This, of course, is in most striking contrast to commercial indemnity (payment of certain specified amounts of cash *toward* hospital or surgical expense, in some cases covering perhaps only a low proportion of the bill). There are no arbitrary limitations on duration of hospital stay, since it is the purpose of the programme to cover all *necessary* hospital days. Review of hospital stay and the initiation of case disposition activities in order to prevent unnecessary prolongation is undertaken by the Fund's Area Medical Offices, which use public health nurses to good advantage in such situations. There are no excluded disease categories as such (even tuberculosis and mental disease are paid for during diagnostic and short-term hospitalization episodes). Tonsillectomy and dental services are not covered.

Administrative costs as low as 2·9 per cent. have been achieved (Social Security Administration, 1952). This has been partly the result of the volunteer assistance of the members, especially of the local union officers, but it is also partially inherent in the simple method by which the Fund's money is obtained. The royalty is paid on each ton of coal mined at the source, the money being sent directly to the Fund by the coal company. Accordingly, there are no overheads for salesmanship, advertising, premium collection, or other paraphernalia of selling insurance. Economy and quality are also fostered by the fact that the Fund administers its own programme through its own national and ten Area medical offices. This tailors the programme to the mining families' specific needs and creates the atmosphere not of a fiscal liability but of a health programme.

The Fund has utilized the best existing hospitals it could find in or near the mining vicinities, making billing arrangements on an inclusive *per diem* rate based on cost whenever possible. Physicians have been paid primarily on a fee-for-service basis, but retainer and other time-based arrangements are increasing in number.

The experience of the Fund showed that it needed to subsidize the development of new hospital beds near some of the mining communities, since satisfactory hospital facilities either did not exist or were not available to the miners. Accordingly, ten "Memorial Hospitals" are at present being constructed in Kentucky, southern West Virginia, and Virginia, with United Mine Workers' funds. (As might be expected, some of these have met with medical opposition since they upset the *status quo*.)

Medical Group Practice and the Miners' Fund.— The Fund also has learned that the development of medical group practice in health centres is necessary to enable the provision of comprehensive treatment, with emphasis on preventive, ambulatory, and rehabilitative care.* The previous pattern of home and office care by general practitioners through the so-called "check-off" system (voluntary capitation prepayment for general practitioner office and home calls and some dispensed drugs) was in deserved disrepute among both the miners and their community doctors. This critical situation calls for a replacement of what has been traditionally called the "company doctor" system. Hence, experiments now being made on methods of stimulating medical group practice, but in the framework of a wide free choice of participating physicians, have already promised important results.

Systematic associations of specialists and general practitioners, with an adequate range of auxiliary personnel, and necessary laboratory, X-ray, and other facilities, are being sponsored and stimulated. This type of development makes for a more efficient use of the physicians' time, lower overheads, and a better basis for budgeting payments from the Fund. One key group of medical practitioners is sponsored by a non-profit-making corporation, composed of and directed by local and district union leaders who form its Board of Directors. The Board provides the "Community Health Centre" in which the medical group provides service. Further developments of this type are being encouraged.

3. Direct Service Plans

Another major American trend in providing medical care has been the growth in the number of Union Health Centres. Diagnostic or treatment facilities are maintained at a central point near the trade union member's place of employment, either by his health and welfare fund or by his trade union.

The first of these, the Union Health Centre of the International Ladies Garment Workers' Union (A.F. of L.), was established in 1913 after the New York City garment workers' strike of 1910 (Price, 1946). It is now transferred to and partially supported by a union health and welfare fund. Some twenty smaller health centres modelled on the original New York Centre are now maintained in various communities throughout the United States by the I.L.G.W.U. Women form the large majority of the membership of

* Medical group practice in the United States was reviewed by McKeown (1948). Since that time a summary monograph and a chapter on the subject have appeared (Hunt and Goldstein, 1951; Goldstein, 1952). See also Falk (1949) and Parran (1953).

this union. The parent centre now occupies a building with 100,000 square feet of space; some 175 part-time and nine full-time physicians handle some 1,800 patients per day. No home calls are made except as part of the administration of a disability indemnity programme.

The Labour Health Institute of the Teamsters' Union (A.F. of L.), in St. Louis, Missouri, arose in 1945 from a collective agreement which by 1949 covered some 8,000 members (Richman, 1949). It provides a very comprehensive range of medical services, even including (as is unusual in the United States) considerable prepaid dental care. The quality of service is reported to be high.

The Amalgamated Clothing Workers (C.I.O.), the counterpart in the men's clothing industry of the I.L.G.W.U., which has built monumental ambulatory health centres in many cities* through its medical benefit funds, stresses preventive services. These centres are financed by 3½ per cent. of wages (2 per cent. from the employer and the rest from the employee).

The New York Hotel Trades Council, through its Hotel Association Health Centre, developed its own medical facilities in 1950 (Guidotti, 1953).

What may be a new trend has manifested itself in Philadephia, where eleven constituent unions combined in an "American Federation of Labour Medical Service Plan" (McDonough, 1952). Such examples of co-operation between inter-craft trade unions are uncommon in the health field. If they spread, they can be of tremendous moment to the future of medical care in the U.S.A. Stirrings in a similar direction are to be found in Chicago, Illinois, where a Union Health Centre is planned, spearheaded by the Janitors' Union (A.F. of L.).

In San Francisco, to cite another episode, a resolution was passed (Weinerman, 1952) that some 100,000 members in A.F. of L. unions should develop such an inter-craft union health centre. This was voted unanimously by its Council following the recommendations of the Wienerman Report, so named after its author. This action aroused great apprehension in medical circles, because it seemed that it would involve a majority of the population of the city and thus set in motion vast changes. Perhaps as a result of this medical apprehension, no action has been taken, even though the 100,000 members of the A.F. of L. are still unanimously on record for it.

4. Evaluation of Collective Bargaining for Medical Care Benefits

It should be understood that the self-administered funds (such as that of the Mineworkers) and the direct service centres (such as those of the Garment workers) represent an *avant garde*. The great majority of the benefit agreements are essentially company administered, and frequently commercial insurance company administered. Most of them provide only a certain amount of cash toward meeting part of in-hospital (and surgical) expenses and toward some wage replacement in the event of disabling illnesses of between one and 24 weeks*. Some, such as the United Automobile Workers and the United Steel Workers (C.I.O.), have benefits under nation-wide Blue Cross and Blue Shield contracts.

The reason is easy to see. The ease with which workers in different plants in different parts of the country could be offered relatively uniform benefits through these mechanisms is clear, but the creation and operation of direct service plans would not only be difficult but would also disturb existing patterns of medical practice. Both hospitals and physicians prefer traditional methods of assuring payment, and neither have had to adjust very greatly as a result of the developments to date. The plans obviously give the worker a *certain* amount of security and have broken down *some* of the financial barriers to the receipt of medical care which he formerly faced.

However, the Blue Cross, Blue Shield, and commercial insurance plans are seriously lacking in any emphasis on prevention, health education, early diagnosis, rehabilitation, geriatric care, and other aspects of a sound preventive health programme. The fiscal basis of many commercial plans for medical indemnity makes no provision for health conservation through periodic health examinations, immunizations, and maternity and child-health instruction. Where home and office care is excluded, there remains a financial barrier to early and preventive care, and to treatment for the home-bound chronically-ill patient. The quality of the medical care provided under cash indemnity is considered to be "none of the plan's business".

Any limited (non-comprehensive) plan of medical care increases the nation's hospital bills unnecessarily, because many cases are admitted to hospitals and retained longer than would otherwise be the case because of the financial incentive of in-hospital admission to both patient and doctor, since hospital days are prepaid but home and office care are not. Dependent's benefits are usually inadequate, but the bills must be paid by the worker. "Adverse risks" of various types are excluded. In at least some

* *e.g.* New York City, Philadelpia, and Chicago.

* We have more or less neglected temporary disability indemnity in this paper. In the United States most of this is now on a commercial insurance basis, although some is administered through employees' mutual benefit societies and other self-insurance mechanisms. In a few states (Rhode Island, California, New York, and New Jersey) it is on a state-wide social (compulsory) insurance basis (Sinai, 1949).

communities, surgical charges to the patient have risen each time the rates of surgical indemnity fees were raised, so that the surgeon, but not the patient, gained financially.

A significant amount of the premium dollar goes into medically unproductive items, such as brokers' commission, salesmen's profits, advertising, collecting expenses, etc. For reasons of national pride, we will not refer to allegations of corruption, such as the direct or indirect bribes which may be offered to officials in industry or labour who have the power of awarding a contract to a particular insurance carrier. Administratively, the filing of claims, individual processing, etc., is little less than a monstrosity. Re-duplication, uneconomical size, inappropriate competition, etc., all abound. Little opportunity is provided for the workers' self-administration or for their representation on policy bodies.

The inadequacies of in-hospital insurance and the limitations of surgical benefits are so apparent that a break in the direction of medical group practice sponsorship linked with medical care insurance is clearly indicated. The Health Insurance Plan (H.I.P.) of Greater New York (Baehr, 1950), and the Permanente Health Plan of the Kaiser industries (Garfield, 1952) are two important developments in this direction. Both are based consciously and articulately on:

(*a*) group prepayment of the costs of medical care,
(*b*) medical group practice to render and purvey it,
(*c*) financial inducements to prevention of illness,
(*d*) overall responsibility of groups of physicians for the total health of groups of people, especially of families.

5. Discussion

What are the probably continuing and future trends in the field of medical service plans sponsored by trade unions? Perhaps the following remarks are relevant:

(*i*) *Medical care programmes created by trade unions* are an important and growing facet of the medical care system in the United States. The trade unions are developing an informed nucleus of personnel who know the specific needs of their own members and their families, and how those needs can be met. Their voices increasingly carry weight in labour-management negotiations at every level.

(*ii*) If any *Federal medical care programme* were to be enacted in the near future (and this is remote under the present administration), it would inevitably be quite different from any programme proposed but not enacted in 1943. Some future administration would utilize the newer trade union direct service facilities, and probably also, at least at first, the trade union fund administrative mechanisms, since these have built up a body of personnel, experience, and practice which could not be lightly disregarded, just as would Blue Cross, Blue Shield, and even commercial insurance. The ultimate trend might be the direct government administration of an analogue of the British National Health Service, but such an outcome does not yet appear to be on the horizon.

Other estimates of the direction of present trends may be listed as follows:

(*i*) *Comprehensive medical care* prepayment is increasingly important. The provision of office and home care, and of preventive and rehabilitative services, in addition to in-hospital care, seems to be on the increase.

(*ii*) *Medical group practice* is growing as a key device in the development of quality and economy of service. This will, of course, be combined with a continuing need in isolated communities for individual practitioners, but even they will thus be backed up by a team of personnel and facilities on a "regional" basis. The broadened health team would include the visiting nurse, the dentist, the trained non-M.D. medical care administrator, and the social worker.

(*iii*) *More mature relationships are developing with public programmes of health and welfare.* Such a development is typified by the mobilization and attempts at improvement of the State Vocational Rehabilitation Schemes, backing of the formation and development of the Public Health Department Services, the Welfare Departments, and other organizations for public medical care.

(*iv*) *Teaching and research activities* are beginning to grow, with ties to the medical, public health, and related health professional schools.

(*v*) Integration with *workmen's compensation* and the *occupational health services* is beginning to develop.

(*vi*) More mature *social and community planning* is developing as part of an emphasis on primary prevention and positive health conservation.

6. Summary

(1) Through collective bargaining by trade unions, organized medical care plans have exhibited a striking growth in the past decade in the United States of America.

(2) Hospital and surgical coverage has been the commonest form of medical plan, "comprehensive" medical care being unusual.

(3) The United Mine Workers Welfare Retirement Fund is described in detail.

(4) Direct service medical group practice plans are on the increase.

(5) Present methods and plans are evaluated.

(6) The existence of these plans will probably influence the provisions of any future national health insurance legislation.

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DIFFERENCES IN THE NATIONAL HEALTH SERVICES OF ENGLAND AND SCOTLAND

BY

I. A. G. MACQUEEN

Health and Welfare Department, City of Aberdeen

It is strictly incorrect to say that there is a National Health Service in the United Kingdom. There are three separate services, covering respectively England and Wales, Scotland, and Northern Ireland. While broadly similar, the three vary in quite a number of points. The present article is an attempt to indicate the main particulars in which the service in Scotland differs from that in England, to explain why these variations came into being, and to discuss possible results accruing from them.

GEOGRAPHICAL FACTORS.—Scotland comprises one-third of the territory of Britain and contains only one-ninth of the population; by English standards, large tracts are almost uninhabited. If on a map you draw a line slanting from the mouth of the Clyde to the Firth of Tay and then turning at right angles to pass up to the Moray Firth, and a second line (parallel to the first portion of the other) from Ayr to Dunbar, you will have divided Scotland into four zones. The narrow belt in the middle—the Central Lowlands—holds over 3½ million persons in some 4,000 square miles (*i.e.* it corresponds to an English hospital region of average size and more than average density); the North-Eastern triangle contains 750,000 people in 4,500 square miles (*i.e.* it is a shade larger than Devon and Cornwall but less thickly populated) and the population density in most of the triangle is even less than would appear from the figures, because half the inhabitants live in the cities of Dundee and Aberdeen; the Southern Uplands extend over 5,000 square miles of hill country and have 300,000 inhabitants (a sparsity far beyond anything found in England); and the beautiful but desolate north—the Highlands and Islands—stretches over 16,500 square miles but contains only 400,000 people (*i.e.* it covers an area as large as one-third of England but has a population rather greater than Cumberland or rather less than Somerset).

The geographical configuration made it impracticable to have less than five hospital regions in Scotland, and determined that three of the regions should serve populations of very restricted size. The Western Hospital Region (based on Glasgow and extending from Argyll to the Solway) and the South-Eastern based on Edinburgh and stretching from Fife to the Border) resemble English regions, but the North-Eastern (based on Aberdeen) serves 500,000 persons, the Eastern (based on Dundee) only 400,000, and the Northern (based on Inverness)—the one region without a University—under 200,000. These regions may serve as a yard-stick to measure whether (as is often alleged) regions containing several million people are too large.

Again, in the development of Local Health Authority services in England, towns with populations of 50,000–200,000 tended to play a leading part: one has only to think, for example, of county boroughs like Ipswich, Reading, Middlesbrough, Barnsley, and Carlisle, or even of large non-county boroughs like Stockton-on-Tees, Luton, Cambridge, Mansfield, and Swindon. Scotland, however, has only seven burghs of over 50,000 inhabitants—the four main cities, and Paisley, Greenock, and Motherwell. Similarly, while English administrative counties with under 75,000 inhabitants are rare, in Scotland most counties have populations below that figure and none is so populous as to require delegation of health or education functions to divisional authorities. The populations of most of the Scottish Local Health Authorities are so small that it was deemed impracticable to place on them responsibility for the provision of health centres and ambulance services: for both of these responsibility has remained with the Secretary of State for Scotland, although in the case of the ambulance service the duty has been delegated to the Regional Hospital Boards.

The small populations served by Scottish Local Authorities also afford an explanation why the areas of Executive Councils in Scotland do not always coincide with those of Local Health Authorities: there are 55 of the latter (although, through joint

appointments in a few areas, there are only fifty medical officers of health), and 25 of the former.

HISTORICAL AND CULTURAL FACTORS.—Scotland's history differs from that of England in many respects, and not least in that the smaller country was never crushed beneath the heel of a conqueror: Scotland had only a partial Roman invasion, no Norman conquest, and no strong Tudor monarchs. Central government (in health matters the Department of Health for Scotland) has never enjoyed in Scotland quite the same amount of respect as is given to its analogue in England, a fact which may further explain the decision of the central authority to retain for itself the power to provide health centres.

The Caledonian zeal for learning is well-known: there were four Scottish universities (each with a medical faculty) when there were still but two in England, and, although England now has some fourteen full universities, it is probably true to say that universities play an appreciably greater part in the life of Scotland than in that of England. Certainly in Edinburgh or Aberdeen one is conscious of being in a university city, whereas in Leeds or Nottingham one is in a city that contains a university. To the Scot it was natural, instead of setting up independent Boards of Governors for teaching hospitals, to think of these hospitals as constituting the cultural centre of each hospital region, and to safeguard the teaching of undergraduates and post-graduates by establishing in each region a Medical Education Committee of which at least one-third of the members must be from the university (a stronger university representation than was accorded in England to the boards of the teaching hospitals). The teaching hospitals of Glasgow, Edinburgh, Aberdeen, and Dundee (which have hitherto provided clinical education for about one-third of the medical students in Britain) are in any case so predominant that to organize a regional hospital service without them would have been a task like producing *Hamlet* without the Prince of Denmark. Inherent in the different fate of the teaching hospitals was the necessity for the creation in Scotland of a special Hospital Endowments Commission.

Again, a teaching hospital in Scotland has traditionally had as its administrative head a medical superintendent serving as an invaluable link between the medical staff and the board of management. In England, where medical superintendents were a feature of municipal hospitals but not of voluntary hospitals, it was perhaps natural that after 1948 they should tend to disappear except in mental and other special hospitals. In Scotland it was equally natural that they should remain.

From 1915, the Highlands and Islands had an integrated medical and nursing service, based on the general practitioner and the combined, all-purpose, domiciliary nurse, and supplemented latterly by the resources of a hospital and specialist service. In other words, this huge tract of mountains, glens, and sea-lochs, with difficult communications and few inhabitants, had a form of national health service years before the rest of the United Kingdom.

Before the passing of the Act, local authority health functions in Scotland had for nearly a score of years been concentrated in the hands of counties and large burghs, the latter having populations from 20,000 upwards. There was nothing corresponding to the Urban District and Non-County Borough, and consequently the changes of 1948 did not in Scotland result in the appearance of a frustrated group of doctors who, after having been independent chief officers in small population units, found themselves with status and duties little different from those of county assistant medical officers.

TEMPORAL FACTORS.—The Scottish Act was drafted after some of the tumult that greeted its English analogue had died down. In the light of reason it was possible for the legislators to make a number of small but important alterations in the later Act. For instance, in England the Central Health Services Council had been authorized to advise on services provided under the Act or provided by Local Health Authorities under other Acts, but—presumably through a drafting error—it had been given no power to advise on school health services, which are provided by Local Education Authorities; in the Scottish Act this defect was rectified. Again, after the passing of the English Act it was felt in some quarters that medical members might in course of time come to dominate Regional Hospital Boards and Hospital Management Committees. As a safeguard, the fourth schedule of the Scottish Act laid it down that at least half the members of each Regional Hospital Board and of each Board of Management must be persons other than medical practitioners.

Yet again, the English Act was drafted during a temporary wave of hostility to local authorities and their services, but by the time the Scottish Act was taking shape, saner forces were at work. Hence the Scottish Act included a specific power of Local Health Authorities to conduct research; and the Scottish Health Services Council has a standing advisory committee on local authority services, a committee which the English counterpart does not yet possess. Similarly, while the Health Services

Council in England has so far included in its membership only one medical officer of health at a time, the Scottish equivalent has from its inception contained two medical officers of health in a council of smaller total membership.

Effects on General Practice

The explicit differences between the Acts are least in respect of general practice. Yet there are discrepancies arising not so much from legislation as from use and wont. Whether as a result of the existence of the Highlands and Islands medical service for a third of a century before the commencement of the National Health Service, or as a result of the pre-eminence of the Scottish medical schools in the early decades of the 20th century, the general medical practitioner in Scotland—and especially in the country areas—enjoys a prestige appreciably higher than is common in England. It has to be remembered that the rural family doctor in Scotland often served as assistant medical officer of health for his area, treated his patients in a small hospital, co-operated with a combined health visitor and district nurse, and was in short a complete social and clinical physician.

This fact has, paradoxically, sometimes had the effect of making the Highland tail wag the urban dog. For example, when it was decided that any general practitioner in Scotland could undertake midwifery without special experience or inclusion on a separate list, consideration was undoubtedly given to rural areas where there may be a single practitioner in an extensive tract of country. Whether it was justifiable to apply this criterion to the industrial belt—in which Glasgow alone has a population nearly thrice as numerous as that of the entire Highlands and Islands—is a matter of controversy.

Among local health authority doctors, these Cinderellas of the medical profession, the remark is sometimes made that the Ministry of Health and the Central Health Services Council are in danger of forgetting that there are any doctors other than the staffs of hospitals, while the Department of Health for Scotland and the Scottish Health Services Council tend to be unaware of the existence of any doctors other than general practitioners. That remark (which, although an exaggeration, contains a nucleus of truth) at least indicates the prestige of the family doctor in Scotland.

Effects on Local Authority Services

In England a number of progressive authorities have already completed health centres; in Scotland, where local authorities cannot legally provide such centres, one solitary centre (newly opened) is the fruit of the activities of the central government department. Local authorities have no responsibility for ambulance services, and the populations served by most town and county councils are by English standards far too small. Yet, curiously enough, the public health service is in a stronger position in Scotland than in England. Three reasons may be adduced: first, while some of the Scottish units are admittedly too small, it may well be that many of the English administrative counties suffer from the even more serious defect of being too large, and, in particular, that counties asked in 1948 to absorb the health services of populous non-county boroughs and urban districts seem in many cases to be incapable of properly digesting the unduly large meal forced upon them; second, whatever they may have left undone, many Scottish local health authorities have utilized their power—a power not possessed by English authorities—to spend money on co-ordination of services; and third, the Central Department in Scotland has from the beginning been less disposed to ignore prevention of disease than was its English counterpart. There is, for example, no English official publication to correspond to the 1951 Report entitled "What Local Authorities can do to promote Health and prevent Disease": this report of the Scottish Health Services Council urged local authorities to "play a leading part in the campaign to improve physical and mental health", invited medical officers of health to study accidents and to apply epidemiological methods to their control, indicated that "the educative influence of a progressive local authority can do much" to prevent deaths from respiratory disease, stressed the economic value of preventive services, urged medical officers of health to study social and occupational factors in disease, called for an extension of after-care services, asked local authorities to give attention to reduction of disease in the elderly, called for the promotion of mental health, stressed that "the health visitor is an educator of supreme importance", and asked local authorities to remember the new powers they had been given to promote research. Such a document, issued with the weight and authority of a central council, could hardly fail to stimulate at least some local authorities and to remove the formerly prevalent misconception that the sphere of these authorities had contracted instead of expanding.

A further instance of the attitude of the Central Department to local health authority services may be seen in a speech made by the Secretary of the Department of Health for Scotland on April 24, 1952 (*Health Bulletin*, Department of Health for Scotland, 1952, **10**, 43): here Sir George Henderson publicly stated that local authorities should investigate

diseases of maturity, that the medical officer of health should be as concerned with old people as with pre-school children, and that he

> need no longer mainly concern himself with infectious diseases and sanitation; in fact, he is now a sociologist with clinical insight.

Further examples of this more enlightened attitude on the part of the Department are not difficult to find. In Scotland, Rutherglen was allowed to start a geriatric clinic, Rutherglen and Aberdeen instituted chiropody services for pensioners, Aberdeen set up a night-nursing service as an extension of the ordinary day service, and Greenock and Paisley offered B.C.G. immunization to school-leavers; in England Salford's proposals for a chiropody service and Stoke-on-Trent's scheme for B.C.G. immunization were disapproved by the Ministry of Health.

The above examples should not be taken as implying that local health authority services are in a healthy state in Scotland. The same financial disparities and the same serious quantitative and qualitative shortages of local authority medical, dental, and health visiting staff exist in Scotland as in England; but the smaller country gives much more evidence of being aware of the dangers of the situation and of being concerned to remove them if it is still possible to do so.

Effects on Hospital Services

The differences are greatest in the hospital services, the main points being perhaps the smaller populations served by three of the five Scottish hospital regions, the absence of any division in Scotland into regional boards for non-teaching hospitals and boards of governors of teaching hospitals, and the continued existence in Scotland of the medical superintendent.

These points are clearly connected, and it is extremely hard to obtain objective evidence of the advantages or disadvantages of any one point. There appears to be a fairly general impression that the North-Eastern and Eastern Regions function more smoothly and efficiently than do those serving appreciably larger populations: waiting lists in these regions of 400,000 and 500,000 persons are certainly much smaller than would be accounted for merely by variations in the gross populations served; and the standard of co-operation with other branches of the Service is very high in the "small" units.

As for the medical superintendent, many people in England seem to regard him as unnecessary, whereas most people in Scotland consider him to be an essential link between the staff and the board of management. It is certainly very convenient—to put it no higher—for a consultant in charge of a ward to be able to discuss drugs, operating tables, lighting of a theatre, or plans for a new ward with someone who has medical knowledge but whose primary interest is administration; and it is equally convenient for a board of management to have as its chief adviser an officer with technical knowledge but without any particular axe to grind. On the other hand, in the British Civil Service a system has evolved whereby its highest posts are filled by persons without technical knowledge, and it might conceivably be thought logical to seek to extend this system to hospitals. At any rate, if some of the other variables can be studied and eliminated, it should not be beyond human ability to assess the merits or demerits of the superintendent system by impartial comparison.

In the years of over-heated discussion and impassioned argument that immediately preceded the passing of the Health Acts it was obvious that a substantial section of opinion in England felt that, if the teaching hospitals were brought within the framework of the regional hospital administration, there would be a danger of levelling down, so that these hospitals would be hindered in their research work and in their standard of service through lack of money and staff. It is, therefore, particularly interesting to compare the effects of the English dichotomy of teaching and non-teaching hospitals and of the Scottish policy of unification. On balance, these effects appear to favour the Scottish method. First, there is less reluctance in Scotland on the part of a young consultant to accept a post at the periphery of a region: in England the doctor who takes such a post tends to feel that he has completely lost contact with the men whom he regards as the leaders in his particular specialty. Possibly arising from this fact, the standard of specialist treatment appears to be higher in Scotland than in England: in the main teaching hospitals the standard is probably not dissimilar in the two countries, but as one moves from teaching to non-teaching hospital the decline is far sharper in England than in Scotland. Again, facilities for teaching students tend to be better under the Scottish system: in England the teaching hospitals must use the material actually available to them, but in Scotland the interesting or instructive case can be moved from the non-teaching peripheral hospital to the teaching hospital at the centre. Not least, there is in the larger country a very real danger of the development of two classes of hospital, whereas in Scotland this danger is much less serious. As for staffing and facilities for research, recent official statistics show that the teaching hospitals of England are much more lavishly staffed in all their

departments than the Scottish teaching hospitals, but the staffs of non-teaching hospitals in England complain bitterly of being chronically overworked and of having no time for research. One gets the impression that, while the total amount per head of population is about the same in the two countries, in England the first priority is the maintenance or improvement of the high standards of the teaching hospitals, while in Scotland the emphasis is placed on raising the peripheral hospitals to the level of the teaching centres. It may be, of course, that the Scottish policy is economically unwise, some units being probably too small to be made efficient at reasonable cost.

It is hard to evaluate the amount and quality of research work undertaken in the hospitals of the two countries. In some of the newer branches of medical science (*e.g.* geriatrics) more research seems to be conducted south of the Cheviots, whereas in some of the older branches (*e.g.* obstetrics) this is certainly not so.

If we attempt to judge by the standard of the average hospital care available to a person who falls sick in either country or by the standard of the average time that such a person has to remain on a waiting list, such information as is available appears to favour Scotland. The outstanding feature of the Scottish system, however, is probably not the bringing of teaching and non-teaching hospitals under unified control, and not even the existence of the medical superintendent, but the relative smallness of population in three of the five Scottish hospital regions. These less populous regions function remarkably smoothly, co-operate well with other branches of the Health Service, and do not appear to encounter many of the difficulties found elsewhere: it is perhaps legitimate to infer from these facts that to ask a group of individuals to act as the members and officials of a hospital board for a population of several million persons is to impose on them a task beyond the capacities of normal human beings, and to create a Frankenstein's monster which no one can control.

Summary

The differences in the National Health Services of England and Scotland are least in respect of the general practitioner service, considerable in respect of local health authority work, and greatest in respect of hospitals. Some of the main peculiarities of the Scottish set-up are:

(*i*) three of the five hospital regions serve small populations;
(*ii*) teaching hospitals are controlled by the Regional Boards;
(*iii*) medical superintendents are the rule, not the exception;
(*iv*) the ambulance service is delegated by the Secretary of State to hospital boards;
(*v*) provision of health centres is a matter for the central government department;
(*vi*) local authorities in general serve smaller populations;
(*vii*) no local authorities lost health functions in 1948;
(*viii*) local health authorities have a specific power to undertake research;
(*ix*) the areas of local executive councils are not coterminous with those of local health authorities.

Historical and geographical reasons for some differences are given, and a few of the effects are discussed.

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ADMINISTRATIVE DIVISIONS WITHIN THE NATIONAL HEALTH SERVICE

BY

A. LESLIE BANKS

From the Department of Human Ecology, University of Cambridge

A notable feature of the National Health Service Act is the division of administrative responsibility between the Hospital Authorities, the Local Executive Councils, and Local Health Authorities. It is now widely recognized that this division has serious disadvantages. In the discussion which follows an attempt is made to examine the historical reasons for these administrative divisions, to outline some of the present difficulties, and to suggest a possible line of action.

Der Historiker ist ein ruckwarts gekehrter Prophet, but in dealing with the growth of state medical services the historian cannot look back very far. Even so the speed of development in Britain has been quite remarkable.

Historical Introduction

Section 63 of the National Health Insurance Act of 1911 contained the remarkable provision that when sickness in any area was found to be excessive, by reason of bad housing or other injurious influences, payment of the extra amount disbursed in sickness benefit by reason of such insanitary conditions could be claimed from the local authority responsible. The motives which led to the insertion of this provision in one of the early State ventures into the field of clinical medicine are worthy of consideration. For nearly 60 years the health policy of local and central authorities in Britain had been directed towards sanitary improvement of the environment. Then, with the turn of the century, came the Boer War, the Report of the Inter-departmental Committee on Physical Deterioration (1904), and, in 1905, the appointment of a Royal Commission to enquire into the laws relating to the relief of poor persons within the United Kingdom. It is interesting to note that the members of the Commission included Beatrice Webb, Octavia Hill, George Lansbury, and Charles Booth, the Liverpool shipowner who wrote *Life and Labour of the People in London* (10 vols., 1892–97). The appointment of this Royal Commission on the Poor Laws in 1905 was one of the last acts of the Conservative government of the day. Then came the political landslide of 1906, with an overwhelming Liberal majority, and the emergence of a dynamic Welshman, Mr. Lloyd George. After measures relating to housing, workmen's compensation, land, and old age pensions, the Government turned its attention to national insurance against sickness and in 1911 made a direct entry into the field of curative medicine.

Hitherto experience of organized medical care had been limited to the Poor Law, the Post Office, and allied medical services, and the detested "contract practice" in which the individual doctor sold his services to provident and medical aid associations by a process of bargaining. It was against this background that Mr. Lloyd George's Bill "to provide for Insurance against Loss of Health and for the Prevention and Cure of Sickness and for Insurance against Unemployment and for purposes incidental thereto" was introduced. Any insurance scheme must be safeguarded against abuse, and anything as revolutionary as "ninepence for fourpence" might well expect to be abused. It would not be unnatural, therefore, to imagine that the question of medical certification might loom large. How much influence also the continental belief in *polizeimedizin* exerted is not clear, but before 1914 the influence of German opinion must have been quite powerful in Britain.

The First National Health Insurance Act, 1911

Given this background, a number of matters become more clear, including the apparent neglect of prevention, and the cavalier treatment of the medical profession at that time. To return for a moment to Section 63 of the 1911 Act, with its nine subsections and detailed instructions as to procedure, its philosophy was, in essence, punitive.

> Where it is alleged that the sickness . . . among insured persons . . . is excessive . . . and that such excess is due to the conditions or nature of employment of such persons, or to bad housing or insanitary conditions in any locality, or to an insufficient or contaminated water supply, or to the neglect on the part of any person or authority to observe or enforce the provisions of any Act relating to the health of workers in factories, workshops, mines, quarries, or other industries, or relating to public health, or the housing of the working classes . . . or to observe or enforce any public health precautions, the Commissioners or the society or committee making such allegation may send to the person or authority alleged to be in default a claim for the payment of the amount of any extra expenditure alleged to have been incurred by reason of such cause aforesaid.

Then followed the requirement that the cost of any excess of the average expectation of sickness by more than 10 per cent. should be made good by the defaulter, whether he be employer, local authority, or water company. This outlook may explain also the attitude towards the medical profession. Doctors would be necessary, it is true, to provide domiciliary medical care, but equally to ensure that insurance benefits were not abused by excessive sickness and prescribing. Club and contract practice had not, to put it mildly, achieved a very high standard of regard for the doctors. Indeed the "sixpenny doctors" of the working class areas,

so-called because that was their standard fee, must have seemed supremely unimportant to a Chancellor bent on driving through a highly controversial measure. As Sir Clifford Allbutt, Regius Professor of Physic in the University of Cambridge, pointed out in *The Times:*

> The Chancellor was content with an antiquated notion of medicine and of medical service. He took for granted, without enquiry, a notion built of some vague knowledge of village clubs and of the old fashioned *vade mecum* way of doctoring.

The determined opposition of the medical profession must have come as a surprise, but, even so, a capitation fee of 6*s*. (later increased to 9*s*.) and the threat to use whole-time practitioners as "strike breakers" if doctors did not participate in the scheme, show the level of esteem in which general practice was held by the Government only 40 years ago.

The National Health Insurance Bill became law on December 16, 1911, and came into force on July 1, 1912. A few months later a special Representative Meeting of the British Medical Association released all doctors from their pledges not to accept service. The first National Health Insurance Service dates effectively, therefore, from 1913, and in the following year came the First World War. For the next 4 years there was little time to consider such matters, and by 1918 the national outlook had changed remarkably.

1918–39.—As early as 1910, Mrs. Beatrice Webb, one of the signatories of the Minority Report on the Poor Laws (Wakefield and others, 1909) had said:

> It is not even the business of the (Poor Law) medical officer to reduce sickness in his district. All that he is charged to do is to "relieve destitution in a certain specialized way", namely, to supply "medical relief" to those applicants who have braved the deterrent attitude of the Relieving Officer and satisfied him that they would otherwise be without it. From first to last, in short, the outdoor medical service of the Poor Law has no conception of the Public Health point of view (Webb, 1910).

At the end of the First World War a Departmental Committee on Local Government, with Sir Donald Maclean as chairman, stressed the multiplicity of authorities concerned with Public Assistance (they instanced that as many as nine different authorities might deal with one case) and described "the largest and most intractable case of overlapping, namely, that of the (Poor Law) Guardians as against the Health and Education Authorities." The Committee recommended the abolition of the Guardians and the merging of their Poor Law functions into those of the County and County Borough Councils (Maclean, 1926). Their proposals reached fruition in the Local Government Act of 1929. Meanwhile a most important investigation into the machinery of government had been carried out by the Haldane Committee, and it was recommended that a Ministry of Health should be established. This Ministry, with responsibility for the central oversight of Local Government, the Poor Law, and National Health Insurance, would be in an ideal position to co-ordinate the hitherto divergent medical services, and an advisory council to the new Ministry lost no time, under the chairmanship of Lord Dawson of Penn, in making recommendations for the unification of medical and allied services on a regional basis. They recognized that:

> as complexity and cost of treatment increase, the number of people who can afford to pay for a full range of service diminishes. Moreover, enlightened public opinion is appreciating the fact that the home does not always offer the best hygienic conditions for dealing with serious illness.

It is interesting to scan the many papers and discussions on the advisability of a national health service which appeared at the end of the First World War. Sir William Osler was undoubtedly expressing the views of many people when he opened a discussion at the Royal Society of Medicine in 1918, on the future of the medical profession under a Ministry of National Health.

> With intellectual weakness in high places the profession has too often suffered the pace to be set by organized ignorance . . . Bumbledom of this type in a new Ministry of Health would only mean the exchange of the whips of Solomon for the scorpions of Rehoboam . . . The war has furnished the profession with a great lever in public health matters: see to it that we have control of the handle.

His comments on the role of the general practitioner should also be noted.

> Is a scheme possible in which he is a paid official of the State, yet a free agent; the executive officer of a city or county council, yet alive to the interests of science? Would he be able to tell a fussy county inspector "None of your blank business" without a thought of the black book at Whitehall? (Osler, 1918).

Clearly the time for a national health service was not yet, and the infant Ministry of Health contented itself with the administration of existing services and the consolidation of measures to improve the environment. The National Health Insurance Service had already passed from the stage of being a novelty to that of an accepted part of life, and by the 1930s its main preoccupations were laxity of certification and prescribing, and the inadequacy of the capitation fee.

Meanwhile the County and County Borough Councils were emerging as the major authorities in the field of preventive medicine, when, as a result of the Local Government Act of 1929, they became hospital authorities also. To say that they entered this new field of curative medicine with enthusiasm is no overstatement, for the hospital activities of some of the large authorities soon overshadowed all else, and in some areas the new principle of a full-time salaried hospital service became an accomplished fact. The voluntary hospitals were not slow to recognize the danger to their own survival, but by the late 1930s the comment was beginning to be heard that "Co-ordination of hospital services in regional areas will undoubtedly take place in the near future" (P.E.P., 1937).

THE SECOND WORLD WAR.—Unfortunately the near future was full of menace, and the imminence of the Second World War introduced a new factor, Civil Defence, which was to play an unexpected part in this

co-ordination. The country was divided into large Civil Defence Regions, each with a Regional Controller who could assume the functions of independent governor if cut off from London by bombing. In each region were miniatures of the central government departments, including the Ministry of Health, and hospitals were organized for emergency purposes on a regional basis, and subsidized for their war work from central funds. It happened that in the provinces the regional headquarters were almost invariably in a University centre. The peculiar circumstances and vulnerability of London required a special arrangement whereby the great undergraduate teaching hospitals in the central parts of London became the apical points of sectors extending out as far as 60 miles into the home counties. As will be seen later, it is from these regions and sectors that the hospital arrangements under the National Health Service have sprung. One other influence of the emergency hospital service must be mentioned here. As the war progressed it became evident that withdrawal of the government subsidy would result in severe financial strain on the hospitals, and probably bankruptcy for those which had hitherto been dependent on moneys voluntarily subscribed.

In December, 1942, the Beveridge Report recommended a comprehensive system of social security based on the maintenance of full employment, family allowances, and a national health service. Assumption B of that report called for a health service to prevent and cure disease, and also to ensure the careful certification needed to control the payment of benefit at the rates proposed. Here indeed were the issues of 1911 in a new guise (Beveridge, 1942).

PROPOSALS UNDER THE WHITE PAPER.—After a careful review of the situation, the White Paper, "A National Health Service" (1944), proceeded to outline the scope and requirements of a comprehensive service, including the administrative structure and each of the main branches —hospital and consultant services, general practitioner service, and local clinic and other services. The special circumstances of the service in Scotland were also considered. The method of organization proposed was to make the maximum use of existing facilities and experience, with no unnecessary uprooting of established services. Local organization was to be based on County and County Borough Councils, operating in their normal local government areas where possible, but combining as joint authorities over large areas where necessary.

New hospital areas were to be created and governed by a joint authority, constituted by a combination of existing County and County Borough Councils in the area. A local consultative body, to be known as the Local Health Services Council, was to be established, to serve a similar purpose locally to that of a Central Health Services Council. Area plans were to be prepared by the local bodies for the approval of the Minister, and the joint authorities were to be free within the plan to organize the services as they wished. The voluntary hospital system was to continue side by side with the publicly provided hospitals, and voluntary hospitals would participate, if willing to do so, as autonomous and contracting agencies. Certain national conditions, *e.g.* as to remuneration of nurses and appointment of consultants, were to be centrally prescribed.

General practice was also to be centrally organized, with a new Central Medical Board, with which the individual doctor was to be in contract. The assessment of local needs in general medical practice was to be the duty of the joint authority which, it will be remembered, was to be composed of local authorities. A "high place" in the scheme was to be given to a full and careful trial of the Health Centre method. "Where they (*i.e.* practitioners) participate in group practice in Health Centres, remuneration to be by salary or similar alternative". The Central Medical Board was to be given power to require newly-qualified doctors to give full time to the public service in their early years if necessary. The question of the sale and purchase of public medical practices in future was to be discussed more fully with the profession. Local and non-hospital clinic services were to be the responsibility of the individual County and County Borough Councils which collectively made up the joint authority. Child welfare duties were to be as much the subject of the "area plan" as any other branch of the service. New forms of service, for example dentistry and care of the eyes, were to be considered "as soon as circumstances allow".

The service was to be free to all, apart from possible charges for certain appliances, and the total cost to public funds was estimated at £132 million for England and Wales and £15·8 million for Scotland.

The White Paper, with its full explanations and careful historical survey, was clearly designed to form the basis of thorough, and indeed almost leisurely, discussion. In its insistence on retaining the local government pattern, with local responsibility for planning and execution, and indirect central control, it followed the accepted development of national services, to which the National Health Insurance Act of 1911, with its hasty flight from local government, had formed a rare exception. The White Paper was well received, but the British Medical Association found itself confronted with similar fears to those of 1911. There was the risk of loss of professional freedom and independence, the fear of a whole-time salaried service, and the danger of bureaucratic control. Above all there was the dislike of local authority control, which loomed as large in 1944 as had the fear of contractual relations with the "friendly" and "approved" societies in 1911. The Minister of Health, Mr. Willink, proved to be much more sympathetic than had Mr. Lloyd George in similar circumstances, and discussions seemed to be progressing smoothly, when, in the General Election of July, 1945, the Labour Party was returned with a large majority.

THE NATIONAL HEALTH SERVICE ACT 1946

Sufficient indication of the change of tempo is given by the fact that within little more than a year a National Health Service Bill had been presented to Parliament and had become an Act, with the "appointed day" on which the new service

was to begin some 18 months ahead. This was indeed quick work, and from now onwards little time could be spared for the niceties of discussion. That the service came into full operation on July 5, 1948, tells, better than words, of the devotion to duty and organizing ability of the lay and medical civil servants at the Ministry of Health.

One thing was abundantly clear. The reliance placed in the 1944 White Paper on the local authority machinery could no longer hold. The time factor alone would not permit of the lengthy discussions required to adjust differences, settle area boundaries, and review the plans to be submitted by the combined authorities. Apart from this the medical profession, both consultant and general practitioner, and the voluntary hospitals, including the teaching hospitals, had never hidden their dislike of local authority control. It was clear also that the Minister of Health, as the agent responsible to Parliament for the efficient working of the service as a whole, must exercise a degree of central control, including financial control, which was new. The introduction of comprehensive dental and ophthalmic services also called for new machinery.

The framework of the Act is well known, and, unlike 1911, there was a considerable body of experience on which to build. Regional organization of hospitals on a voluntary basis had already proved to be practicable before the second world war, and the Civil Defence Regions had proved their value. It was, therefore, a relatively simple matter to construct Regional Hospital Board areas with a University centre associated with each. The subdivision of the regions into Hospital Management Committee groups proved to be more difficult. It was essential to retain, as far as possible, local interest. On the other hand it would clearly be impossible to retain the governing bodies of several thousands of hospitals, and, at the same time, to provide workable groups to deal with the acute and chronic sick, infectious diseases, tuberculosis, and mental illness. Fortunately the war had left behind a body of experienced men and women who had become accustomed to thinking in terms of larger areas than those for which they had previously been responsible, and the establishment of the hospital service machinery proceeded remarkably smoothly. Consultants and specialists had already been accustomed to service on part-time and full-time contracts under the emergency hospital scheme, so that no violent transition was required. The teaching hospitals, with their associated medical schools, presented special problems, and their independence was guaranteed in England and Wales by grouping them under Boards of Governors, with direct access to the Minister, and control of their own finances.

Meanwhile the general medical practitioners, on whom the bulk of the work was to fall, were becoming increasingly anxious. In place of friendly and leisurely discussions of the White Paper they found themselves confronted with a Bill, which, all too clearly, was going to become a Statute in a very short time. In place of the "strike breakers" of 1911 was the provision that any general practitioner who did not join the service on the appointed day forfeited his right to a share in the £66 million set aside as compensation for the loss of the right to sell his practice. The result was aided by the speed with which the Government proceeded. Once an Act is passed it can only be amended by another Act, and public opinion soon tires of opposition to a *fait accompli*.

Here again, well-tried administrative machinery was available. For nearly 36 years representatives of the medical profession, and the civil servants responsible for the administration of National Health Insurance, had been hammering out difficulties, and it was a relatively simple matter to change Local Insurance Committees into Executive Councils. Even the method of remuneration, by capitation fee, was to hand.

It was also administratively practicable to organize dental services through the Local Executive Councils, but here, unlike the doctors, the dentists had few precedents on which to base negotiations. Their greatest bargaining assets were the facts that if they chose not to join the service they remained indispensable, and that the vast majority of people were accustomed to pay for dental care. They were therefore able to insist on payment by means of fee per service, a method of remuneration which had always applied to pharmacists dispensing prescriptions under the older service.

One unexpected complication nearly marred the smooth introduction of medical services. As the appointed day drew near it was realized that the promise of free eye services could not be implemented as intended, *viz.* through the hospitals, for these had neither the accommodation nor the staff to meet the enormous demand anticipated. A supplementary ophthalmic service was therefore improvised through the Executive Council machinery, whereby the strain might be taken by opticians, and specially qualified ophthalmic practitioners, working in their own consulting rooms. The cost of this service has been much criticized, but without such an arrangement the Minister's pledge of a free and comprehensive service could not have been fulfilled.

Meanwhile, what of the Local Authorities who were to have been the lynch-pins of the earlier White Paper? County and County Borough Councils were now to be recognized as the major Local Health Authorities, with power to build Health Centres and to act as the connecting link between domiciliary medical care and the hospital. To this end they were to provide midwifery services, to assume full responsibility for district nursing and ambulances, to provide domestic help, and, rather vaguely, to become responsible for the care and after care of the sick, including the tuberculous and the mentally ill, in their own homes. It is possible that many of these Local Authorities had been somewhat nervous of the earlier proposals, for fusion of town and county for hospital services might well mean that the former carried the responsibility for the latter. Apart from this, many authorities might view with anxiety the possibility that submergence of one area into another for one specific purpose, *viz.* health, might lead to a similar process for other purposes also.

After the flurry of negotiation, preparation, and improvization, the introduction of the service on July 5, 1948, seemed almost an anticlimax. On that day the Minister of Health assumed responsibility for a service which depended, for its success, in England and Wales, on 14 Regional Hospital Boards sub-divided into 387 Hospital Management Committees; 36 Boards of Governors; 146 Local Health Authorities; and 138 Executive Councils.

The Present Position

After 5 years it can be said, quite dispassionately, that from the patient's point of view the National Health Service has worked reasonably well—at a price. How high that price is may be assessed by comparing the estimate of £132,000,000 for England and Wales in 1944, with the estimated gross cost of £424,450,500 for 1952–53. Comparable figures for Scotland are £15,800,000 and £51,364,000.

In considering some of the problems created by the local divisions of administrative responsibility, it is necessary to remember that the State is not merely interested in medical care for its own sake. It has a number of other irons in the health and welfare fire, including housing, family allowances, national insurance, national assistance, and food subsidies. Indeed housing, good food, and the relief of poverty, are, in themselves, weapons of great potency in the prevention of disease. It is unlikely, but not impossible, that the State might at some future date be compelled to say, in effect, "We no longer need a vast medical machine. We can, and are, attacking the root causes of disease in other ways. What we now require is strict economy and rigid control of certification and sick absence."

Financial stringency, flagrant abuse of the service, incompetent local administration, or neglect of their duties by those in the service, might also render direct intervention necessary.

Until the last war, central government departments had little experience in the day-to-day running of services. Thorough consideration of local plans, with due regard to the state of the nation's finances; the spurring on of defaulters in local government and the checking of the exuberant; impartial enquiry and arbitration; and a meticulous knowledge; were their main activities. The Ministry of Health in particular, in the first 30 years of its life, established a high reputation for informal contact with those concerned with day-to-day local government, and the counsel and advice of its officials were sought and welcomed by everyone.

Partly as a result of the local sub-division of responsibilities for the health service, that role no longer holds, and the Ministry finds itself in the unwelcome position of having to interfere directly in the details of administration. The position is not made any easier by the difficulty of reconciling the venerable system of government finance by the year with the expenditure of local bodies, which should plan by decades and even, in the case of the Regional Hospital Boards, by centuries.

Turning to the local picture, it is becoming increasingly clear that many of the problems now apparent did in fact exist before. The general practitioner, for example, has always worked in comparative isolation, often under conditions which were far from ideal, and general practice has always been a "dead end" in the sense that there was no hierarchy for promotion. The curative work of the general hospitals and the preventive services of the Local Authorities were always sharply separated, except for a brief period after the passing of the Local Government Act of 1929. Even the transference of responsibility for the in-patient care of infectious disease, tuberculosis, and obstetrics from the Local Health Authority to the Hospital Service merely anticipated by a few years a change which the altered character of that work would have made inevitable.

Indeed the incalculable factor at the present time is not financial and administrative, but arises from the difficulty of foreseeing the effects of the rapidly changing pattern of disease. It seems clear that the emphasis in medical care is shifting from the hospital wards to the out-patient departments and the home, and that the social circumstances of the people, and in particular of the family as a unit, will come

increasingly to dominate the picture. That is particularly the case with disabilities requiring prolonged care, especially in the older age groups.

Meanwhile, everything points to the need for unification of services. The interests of economy, the requirements of efficient administration, and, above all, the need to detect and prevent disease in the early stages, all call for co-ordinated effort, and it is the weakness of the health service that the present administrative divisions make combined effort difficult. Members of Regional Hospital Boards would probably be unanimous in agreeing that they are not satisfied with the progress they are making, or with their relations with the Teaching Hospitals and Hospital Management Committees. The obstacles are not entirely financial. The remoteness of the "Region", sometimes a hundred miles away from the peripheral hospitals, makes the Board member almost entirely dependent on his officers for information, and gives to the decisions of the Board a sense of detachment which is somewhat unreal. In contrast with the Regional Boards, the Hospital Management Committees have at least the satisfaction of contact with their hospitals and the privilege of grumbling at the Regional Hospital Boards when difficulties arise.

The Teaching Hospitals are perhaps the most favourably placed, for they are directly responsible to the Minister for their own groups of hospitals, and for the provision of certain regional services by agreement with the Regional Hospital Boards.

Co-ordination within the hospital service depends much on individual effort, and particularly on the readiness of chairman and officers to meet at frequent intervals. Liaison with other branches of the health service depends almost entirely on the officers, and those few members who can find time to sit on both sets of committees.

Local Executive Councils seem to be sinking rapidly into the mechanical routine which characterized their prototypes, the Local Insurance Committees. That is not surprising in the light of the enormous mass of routine work with which they have to deal. Supplementary eye-services, dental care, and the minutiae of record keeping for the domiciliary care of nearly 50 million people do not leave much time to reflect upon the wider issues, or to enquire into the progress of other branches of the service. The fact remains that it is with the Executive Council that the general practitioner, to whom so many are looking expectantly to improve the quality of medical care, is in contract.

Local Health Authorities are unique among the local bodies responsible for the administration of the health service in that they contribute 50 per cent. of the cost, by way of rates, to the services they provide for the community. It would, therefore, be surprising if they were satisfied with the present position. Their ambulances are at the beck and call of the hospital authorities and the general practitioner; their district nurses, midwives, and home-helps play an indispensable part in sharing the medical burdens of the community, and in lightening the load of domiciliary and hospital care. For the success of much of their preventive work they are dependent on the co-operation of other branches of the health service over which they have no control. It must also be remembered that County Councils and County Boroughs are responsible for many other aspects of local government, and that, despite their title under the National Health Service Act, their health activities may be secondary in importance.

The Future

All the current problems confronting the National Health Service turn upon the pivot—lack of co-ordination. In the interests of economy and efficiency, action should be taken before the new Boards, Committees, Councils, and Authorities develop such rigidity that remedial action becomes too difficult.

The matter cannot wait upon the emergence of all-purpose authorities, for, given unanimity of opinion (a large assumption), their creation would not be practicable within less than 5 years. Everyone agrees that unification of administration must come, and the establishment of a cadre of highly trained professional administrators, medical and lay, interchangeable between central and local administration, would go far to remedy the present defects in the health service. An important part of the training of such men would be the recognition that the service with which they deal is not, and never will be, static, and that it, like the individual men and women who compose the State and for whom it exists, has a more than material value.

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HEALTH SERVICES OF NORTHERN IRELAND

BY

A. T. ELDER

From the Ministry of Health and Local Government, Stormont, Belfast.

(1) Central Organization

The modern health service of Northern Ireland began on July 5, 1948, in common with that in Great Britain. It is based on the Health Services Act (Northern Ireland), 1948, the provision of which was part of a programme of social legislation passed in Northern Ireland to keep pace with similar laws in England:

Health Services Act (Northern Ireland), 1948
National Assistance Act (Northern Ireland), 1948
National Insurance Act (Northern Ireland), 1946
National Insurance (Industrial Injuries) Act (Northern Ireland), 1946
Disabled Persons (Employment) Act (Northern Ireland), 1945.

Centrally several branches operate on much the same lines as in the British Service. These include the National Insurance and Factory Medical Services under the control of the Ministry of Labour and National Insurance, the Medical Referee Service controlled by the Ministry of Health and Local Government, the care of deprived children operated by the Ministry of Home Affairs (cf. Home Office in London), and a Registrar-General's Department for medical and vital statistics. In general, Northern Ireland has allowed a large measure of devolution of responsibility for the health services. Thus, while the Government exercises a general supervision, the day-to-day operation of the services is controlled by various statutory bodies, such as the Northern Ireland Hospitals Authority, the Northern Ireland Tuberculosis Authority, the Northern Ireland General Health Services Board for general practitioner services, the Health and Welfare Authorities, and the Housing Trust.

It is important to note that ownership of hospitals lies with the appropriate authority, a fundamental difference from the legal practice in England (Ormrod and Walker, 1950). Furthermore, the hospitals authority was charged not only with the provision of new hospitals but also with the provision of facilities for medical and dental research. Such facilities can be given to any body or persons, so that while, by the School Health Service Regulation (Northern Ireland), 1948, the Health Authorities in Northern Ireland may prosecute research, grants for this purpose are obtained from the appropriate committee of the Hospitals Authority. The Ministry of Health and Local Government in Northern Ireland has no legal right to originate or prosecute research as has the Ministry of Health in England (Ormrod and Walker, 1950). On the other hand, the Ministry's power in Northern Ireland is limited to the duty of ensuring adequate co-ordination of services within the powers laid down in the various health enactments.

It may be asked whether such a scheme of devolution of ownership and responsibility is satisfactory. Much depends upon the interpretation by the Central and Local (Hospital) Authorities of their individual responsibilities. For instance, though it is a duty of the Local Authority to provide hospitals, it is also the implied duty of the central authorities to ensure that:

(*a*) minimum technical and professional standards are maintained in new buildings and extensions;

(*b*) no excessive or extravagant spending of public money is incurred;

(*c*) the medical and social needs of each area are met.

Within the framework of such obligations the authority is free to develop its own resources.

The Ministry of Health and Local Government acts as a medium of final appeal in any difficulties and disputes referred to it by the Local Authority.

It would be inaccurate to say that the Hospital Services had developed without difficulties, yet the administrative organization has been built up by the authority with considerable efficiency, and the over-riding power of the Ministry has been exercised only to a very small degree. Indeed, the authority has borne the full brunt of all the initial difficulties attendant upon the establishment of a new service out of the diverse components mentioned below.

The provision of health centres is, by law, a matter for the General Health Services Board and not one for Health Authorities. This gives the Board a wider field of activity and better status than the Executive Councils have in England, but so far no health centres have been set up.

Suggestions for group practice are now being considered by the Board under new regulations comparable to those issued in Great Britain.*

The absence of health centres has not prevented the establishment of local health authority multi-purpose clinics.

It was incumbent on the Province to proceed with the establishment of an effective Public Health Service under the Public Health and Local Government (Miscellaneous Provisions) Act (Northern Ireland), 1946, and the provision of ante-natal, post-natal, school and child welfare clinics has followed a policy dictated by circumstances.

(2) The Hospitals Authority

The hospitals of the Province originated in the following diverse systems:

(*a*) The voluntary teaching group in Belfast from an early Belfast General Hospital, as a result of a Dispensary Act of 1817.

(*b*) A so-called voluntary group of county hospitals built after a County Infirmaries Act of 1765.

(*c*) The workhouse system, entirely rate-aided and dating from the 1840s, including most of the fever hospitals.

(*d*) Voluntary cottage hospitals dating from the late nineteenth century.

(*e*) County mental hospitals originating about 1828.

(*f*) Chest hospitals built as County and County Borough sanatoria (apart from one or two private ones).

(*g*) A war-time emergency hospital in Belfast (from the Second World War).

(*h*) A few minor additions by way of country mansions converted during the post-war era.

Several surveys of the needs of the Province have been made from time to time, the most notable being the Nuffield Regional Hospitals Council Survey (Red Book, 1946). Thus the material available and the ultimate requirements of the Province were well enough known by July 5, 1948.

The lag in hospital development stressed by the Nuffield Surveyors has meant the acceptance of a heavy capital building programme in order to bring hospital provision in line with that in Great Britain. Thus in 1909 3,500 beds were available for clinical instruction in Belfast, and 10,000 in the Province as a whole. By 1952 there were 14,100 beds, and the building programme envisages an increase to over 17,700 by 1962, made up of approximate increases in the following categories :

Geriatrics	1,000
Mental	600
General Medical	300
General Surgical	400
Maternity and Gynaecological	200
Paediatric	200
Other Specialties	900
Total	3,600

This programme includes three or four new general hospitals and a colony for persons requiring special care on account of mental deficiency, but excludes tuberculosis provision, which is to be dealt with separately.

This new provision is spread over a period of time for financial reasons, and is conceived for the whole field of the needs of the various Management Areas. New specialized units, such as a Radiotherapy Centre and a Plastic Surgery Unit, have been established, and, in general, it may be stated that except at the Royal Victoria Hospital Teaching Unit in Belfast City, waiting lists are nowhere very large.

From an economic viewpoint, the proposed new special beds are well within the limits advised for England by the Ministry of Health (1950), and with the full development of Health and Welfare Services some of this new building may prove to be unnecessary. Nevertheless as a result of the lag in building, there is at present still some difficulty in housing the aged and the mentally sick.

The hospitals, numbering just over 70, are grouped under 23 Hospital Management Committees. The teaching hospitals are not separated from the others as in England, though they are managed by a separate Management Committee. The mental hospitals, while nominally under the Hospitals Authority, are managed by a Mental Health Services Standing Committee; those tuberculosis hospitals which are concerned wholly with the treatment of tuberculosis are vested in the Northern Ireland Tuberculosis Authority, but where a tuberculosis wing exists in a general hospital, the responsibility of maintenance lies with the Hospitals Authority, access for treatment being afforded to the medical staff of the Tuberculosis Authority. The Hospitals Authority is also responsible for the provision of the Ambulance Service.

A few anomalies may be noted. One large Roman Catholic teaching hospital elected to remain outside the Health Service Scheme, and exists quite independently to-day as a voluntary institution. Two hospitals dealing with ex-Service patients remain, as before, associated with the Ministry of Pensions (London) and independent of the Northern Ireland Hospitals Authority. One tuberculosis sanatorium, previously a voluntary institution, elected not to be absorbed into the Tuberculosis Authority organization set up under the Public Health (Tuberculosis) Act (Northern Ireland), 1946, but was later absorbed

*Health Services (General Medical and Pharmaceutical Services) (Amendment No. 2) Regulations (Northern Ireland) 1953.

by the Hospitals Authority, and is now part of the latter service though it still deals only with tuberculous patients.

The Mental Treatment Act (Northern Ireland), 1932, was embodied into the Mental Health Act (Northern Ireland), 1946, together with something equivalent to the English 1913 Mental Deficiency Act and the functions of the Mental Health Services include provision for the prevention, diagnosis, and treatment of mental illness and co-operation with other public bodies. A Special Care Management Committee deals with the day-to-day work at institutions for "persons requiring special care", a terminology introduced in order to remove the stigmata of expressions such as "idiot", "imbecile", etc. Certain amendments were introduced in 1953 by a new Act but these were largely of a domestic nature and the fundamental basis of certification and care remains unaltered. Certification of children over 2 years of age is dealt with below under the work of the Health Authorities.

(3) General Practitioner Services

The Northern Ireland General Health Services Board, established by the Health Services Act (Northern Ireland), 1948, consists of a chairman, vice-chairman, and 23 members, and includes representatives from the medical, dental, and pharmaceutical professions, the Health Authorities, and other organizations which appear to be concerned. The staff includes a medical adviser and a lay secretary. At its inception there were approximately 750 general practitioners in the Province, and with few exceptions they contracted with the Board to provide general medical services to the public.

Conditions of service and benefits to the public follow closely and speedily the appropriate changes which have come about in Great Britain. Payments to practitioners, as in England and Wales, include basic capitation fees, "loadings", and special fees allowed by the 1953 Regulations. In view of reports that the Province was over-supplied with doctors, restriction of entry into general practice was sought by the terms of the Temporary Provisions Act (Northern Ireland), 1950. This Act has had the effect of closing the Medical List but the Board is able to admit practitioners where necessary.

As in Great Britain, the general practitioner is anxious to have access to hospital work, but in Northern Ireland this has been limited to eight hospitals of the cottage hospital type, and a few others, mainly for midwifery. With the development of the general hospitals, specialized units, and resident establishments, it is difficult to see how access can be much increased at present.

General practitioners may contract with the Health Authorities for the provision of domiciliary midwifery services, under the auspices of the Ministerial Maternity Services Advisory Committee. This service has functioned smoothly since its inception; special qualifications and experience are not required from practitioners taking part in it, though refresher courses in midwifery are organized by the Medical Services Board from time to time.

Before 1948, there were not enough dentists in the Province to provide an adequate service. Although the position is now somewhat improved, and the introduction of charges has reduced the adult demand, it may be some years before these difficulties are overcome. Surprisingly, this does not apply to the Local Health Authority services, whose dental establishments are now complete.

(4) Health and Welfare Authorities

These Authorities, consisting of one Health and one Welfare Authority for each County and County Borough, acting through the medium of statutory committees, were brought into being by the Public Health (Administrative Provisions) Act (Northern Ireland), 1946. Two interesting features of the operation of the Act are:

(*a*) The transfer of the responsibility for School Health Services from the Education Committees to the Health Committees, so that the medical officer of health is automatically also chief school medical officer for his area and his staff is responsible for personal school health services. Control of expenditure on new buildings, and the provision of special schools, together with the operation of the school meals and milk scheme remains with the Education Committees and the corresponding Ministry.

(*b*) Whereas in England the medical aspects of the Domiciliary Maternity Service are vested in the Executive Councils, these functions are performed in Northern Ireland by the Health Committees.

Ascertainment of handicapped children is a matter for the Health Committees, except that children over 2 years of age suffering from mental retardation of such a nature as to render them incapable of education in a special class or school are notified to the Hospitals Authority, and they then come under the care of the Mental Health Services Committee.

The details of the integration of the preventive services have been discussed by Elder (1950), but a few words may be said here regarding the general policy adopted for public health. The provisions of the Health Services Act (Northern Ireland), 1948, which apply to the duties and permissive functions

of Health Authorities in Northern Ireland followed exactly the pattern laid down for similar authorities in England and Wales by the National Health Service Act, 1946, with the exception of the domiciliary midwifery medical services outlined above. As these authorities were newly formed when the General Health Service was started it was considered politic to ask from each authority interim proposals only for the first 5 years. In 1953, comprehensive proposals were called for to cover the ensuing 5 years, and these deal amongst other matters with the fully developed schemes of clinical services and permissive functions, such as after-care arrangements.

The Health Authority Services now carry their full establishments of medical officers, midwives, and home nurses, almost a full establishment of health visitors and sanitary officers, and a full complement of dentists (except orthodontists).

The Health Authorities planned for their own purposes solely, and proposals for additional clinics follow the usual pattern of:

(*a*) Multi-purpose clinics in populous areas;
(*b*) Smaller child-welfare clinics in rented premises in less populous areas;
(*c*) Mobile clinics in sparsely populated districts.

Special arrangements are to be made for the development of speech therapy, child guidance, and ophthalmic and physiotherapy sessions, while the development of consulting obstetric facilities on general practitioner/midwife ante-natal sessions appears to find favour.

Registers of physically handicapped children are maintained, but building difficulties have caused some delay in the provision of an adequate number of special schools for the physically handicapped.

The transfer of Welfare Services from pre-existing Boards of Guardians to new Welfare Authorities analogous to the Health Authorities was a necessary part of the new scheme. The abolition of the Poor Law, envisaged in the Administrative Provisions Act of 1946, was completed by the passing of a Welfare Services Act in 1949, by which the care of handicapped persons was vested in the Welfare Committees, the system adopted including the giving of financial aid to existing voluntary agencies.

Legislation dealing with the care of "deprived" children, and the protection of children generally, has closely followed the pattern developed in England, though it appears that the link with the medical officer of health in preventive health matters is not as strong as it might be.

(5) Tuberculosis Authority

In 1946, when the Tuberculosis Authority was formed, the death rate from all forms of tuberculosis in Northern Ireland was 83 per 100,000 of population, against 79 for Scotland, 115 for the Irish Republic, and 55 for England and Wales. Although the death rate had fallen progressively from 166 in 1922 it was still so high as to be considered a matter of grave moment. The Authority was formed because of the need for a public body to act as a spearhead of attack. It mainly comprised representatives of the local government preventive services. It has altered its complexion and now includes a highly organized clinical service. The officers at first included a lay secretary and a medical director, but after the adoption of the Spens Report on Medical Salaries some internal re-organization took place, as a result of which there are now a number of chest consultants but no director. The reports of the Authority should be studied with this radical change in mind, remembering also that the Authority is by law charged with the duty of preventing as well as that of curing the disease.

There were certain initial weaknesses in the pattern of tuberculosis control. The liaison with the medical officers of health is now very much closer, copies of all notifications being sent to the appropriate M.O.H., and use being made on an agency basis of certain officers of the Health Authorities, such as home nurses, to avoid duplication.

The questions which would naturally be asked would no doubt include the following:

> Is the preventive aspect of the work of the Authority receiving sufficient attention?
>
> Does the absence of a medical man specifically charged with the duty of assessing the medical statistics lessen the effectiveness of control?
>
> Have the Authority and the Health Authorities of Counties and County Boroughs achieved a sufficient degree of co-operation?

The total number of definite new cases notified during 1951 was 2,063 (1,751 pulmonary and 312 non-pulmonary):

> The decline in the number of cases notified, which was observed last year, has continued (1,848 in 1952), and, whilst it is probably too soon to say that there is anything significant in these figures, the downward trend is nevertheless encouraging.

The death rate for 1952 was 30 per 100,000 of population, having fallen from 45 in 1951. This compares with 31 for Scotland and 32 for England and Wales. The Tuberculosis Act had introduced also a system of "intimation of suspected tuberculosis", which had led to an increase in dispensary examinations from a pre-war annual figure of 5,000 to 40,000.

The Mass Miniature Radiography Service has become exceedingly active and in 1952 more than 75,000 people were screened. The trend noted in the annual reports is that of progressive and adequate provision of equipment, clinic facilities, and radiography services; the waiting list for admission to chest hospitals has been reduced from 700–800 5 years ago to just over 200 in 1952. Admittedly some overhaul of the waiting list had been necessary in any case, but *prima facie* we are presented with a substantial reduction.

B.C.G. vaccinations had totalled 6,000 by 1951, but statistics are incomplete. The following statement appears in the Report for 1952:

> The Authority realizes that if B.C.G. is to be widely applied within a relatively short space of time, the active support and co-operation of the Northern Ireland Hospitals Authority, and the County and County Borough Health Committees must be secured, and arrangements are about to be made to discuss with these bodies the best ways and means of carrying the scheme into maternity hospitals, schools, and child welfare clinics.

That support has been given and a province-wide scheme of vaccination of school leavers has been started. During the third quarter of 1952 the Registrar-General in Northern Ireland reported a mortality rate of 20 per 100,000 of population, a fact which augurs well for the future.

If that portion of the cost of tuberculosis control which can be directly accredited to preventive measures is added to the total cost of local government public health services, the quantum of national expenditure on prevention in Northern Ireland is slightly less than that in England and Wales. It is too soon to say definitely whether a Tuberculosis Authority as such has achieved what energetic measures equally applied along the lines of the system in Great Britain could not have achieved.

(6) Other Services

(*a*) Factory Medical Service.—This is administered by the Ministry of Labour and National Insurance, but medical inspection is carried out by the physicians of the Ministry of Health and Local Government. The question of what form an industrial health service should take is fraught with much difference of opinion, and the theoretical considerations are too well known to require any elaboration here. In Northern Ireland we have the economic reality that the cost of the present service is met by industry itself, and it has to be admitted that very little in the way of real industrial hazards as yet exist in the Province (Hamilton, 1951). Moreover, the general practitioners appointed have been doing the work of examination of entrants into industry for some considerable time. The Factory Acts of Northern Ireland are almost complete facsimiles of the English Acts.

(*b*) Laboratory Service and Control of Infectious Diseases.—Before the inception of the Health Service, apart from the teaching school, the Belfast City Laboratory, and one or two smaller hospital laboratories, little existed by way of a public health laboratory service. Interim developments during and immediately after the Second World War led to the opening in 1953 of a new three-storeyed central public health laboratory in Belfast. A chain of subsidiary laboratories throughout the Province will work with the central reference laboratory. Meanwhile a series of collecting depots has been established where practitioners can leave specimens daily for collection and transportation to Belfast.

(7) Financial Considerations

The comparison of general costs in Northern Ireland with facts given in the excellent summary of Ross (1952) shows that the running costs of the hospital service are, if anything, a little less than those in Great Britain; and the costs of the preventive health services are lower by more than one-fifth. The proportionate running costs of the preventive health services amount to about one-eighth of the total health services expenditure. Though the administrative pattern of the tuberculosis services is different, it is possible to separate out costs appropriate to preventive measures and thus arrive at a reasonably true comparison with proportionate costs in England and Wales.

It must be admitted that these facts take no account of the capital investment programme necessary to bring hospital provision in Northern Ireland into line with provision in Great Britain per unit of population. This will cost the Province at least £14 million. Nor has any money yet been spent on the erection of multi-purpose health centres such as those at Woodbury Down or Edinburgh.

The cost of prescribing in Northern Ireland was admittedly excessive at the outset, but by 1953 the *excessive* cost had been halved. This statement is based on a comparison with Great Britain and should not be misread as a halving of the *total* cost, an ideal as yet somewhat remote.

Finally, in spite of all efforts to control expenditure, the Ministry of Health and Local Government Budget for 1953–54 shows an increase of £378,210 over the corresponding provision for last year to a total of £19,752,290, which includes an increase of 12 per cent. to the Hospitals Authority.

TABLE I

HEALTH AND WELFARE SERVICES ESTIMATES

Year		1953–54	1952–53
		£	£
Statutory	A.—Grants to Welfare Authorities under the Welfare Services Act (N.I.), 1949 ..	40,700	40,000
	B.—School Health Services under the Education Act (N.I.), 1947..	165,000	161,000
Extra-statutory	C.—Health Education Grants	50	50
	D.—Grants for Nurses training as Health Visitors ..	10	375
	E.—Welfare Foods	115,000	107,000
	F.—Remanet of N.I. Evacuation Service	100	6,110
	G.—Grants in Aid to the N.I. Council of Social Service..	3,000	3,000
	Nurses' Salaries Grants ..	—	65
Total		£323,860	£317,600

The total estimate for all services under the Government of Northern Ireland for 1953–54 is £52,728,680, but in making comparisons with Great Britain it must be remembered that the lists of items of the domestic budget of the Province is different from that of the United Kingdom as a whole, which also includes the medical services of the Post Office, and Armed Forces, and so on. Again the Ministry of Health and Local Government deals not only with Health Services but with Housing and Local Government matters. Finance is therefore more appropriately related to population (1·4 million). Tables I and II give the comparative estimated expenditure for the years 1952–53 and 1953–54.

It should be mentioned also that Local Health Authority Services are subject to a 50 per cent. Government Grant (this includes the Domiciliary Maternity Service), the General Health Services to a 100 per cent. grant, and the Tuberculosis Services to a 100 per cent. grant, except those that can be classified as Welfare Services.

(8) CO-ORDINATION

Northern Ireland, with a population of approximately 1·4 millions, about one-third of which is aggregated in the City of Belfast, comprises one compact region of 5,238 square miles. The operation of the services by centralized authorities acting independently of, but co-ordinated by, the government departments is assisted by geographic and social requirements.

In the general field of co-ordination, a useful innovation was the establishment of a liaison committee consisting of the Tuberculosis Authority, Health Authorities, Hospitals Authority, and

TABLE II

SUMMARIZED EXPENDITURE FOR ALL HEALTH SERVICE (ESTIMATES)

Legislation			1953–54	1952–53
			£	£
Health Services Act (N.I.), 1948–52	Payments to N.I. General Health Services Board	A.—Administration	123,600	139,100
		B.—General Medical Services..	1,614,000	2,400,000
		C.—General Dental Services	497,000	622,000
		D.—General Pharmaceutical Services	1,512,000	1,554,000
		E.—Health Centres	1,000	10
	Payments to N.I. Hospitals Authority	F.—Headquarters Administration	90,000	86,000
		G.—Hospital Services	5,761,000	5,430,300
		H.—Supplementary Eye Services	169,900	162,900
		I.—Laboratory Service..	28,000	26,000
		J.—Capital Expenditure on Hospital and Ancillary Services	1,609,000	1,128,000
	Other Payments	K.—Compensation for Loss of Right to sell Medical Practices	83,000	103,000
		L.—Superannuation	113,000	108,000
		M.—Vaccines, Sera, or Other Prophylactics.. ..	2,000	1,700
		N.—Grants to Health Authorities	325,000	299,000
		O.—Payments to N.I. Hospitals Authority for Special Care Services	125,600	93,300
Public Health (Tuberculosis) Act (N.I.) 1946	Payments to N.I. Tuberculosis Authority	P.—Administration	40,650	33,600
		Q.—Hospital Services	554,350	497,800
		R.—Mass Radiography	24,500	22,000
		S.—Other Services	47,000	40,300
Civil Defence Services (N.I.), 1950)	(Civil Defence Act	T.—Administration	1,210	970
		U.—Training	3,000	4,500
		V.—Storage	670	250
		W.—Other Expenses	10	200
Gross Total			£12,725,490	£12,752,930
		Deduct—Z.—Receipts appropriated in Aid	1,738,810	1,818,710
Net Total			£10,986,680	£10,934,220

General Health Services Board. There are as yet no University members or Ministry observers.

After-care services have not yet had time to become fully organized, and it is hoped that the full development of home nursing and after-care now envisaged in the Health Authorities' final comprehensive proposals will have the effect of reducing hospital and building costs by speeding up the turnover of beds and reducing the need for in-patient provision.

The co-operation of the Health Authorities in the B.C.G. vaccination service is a welcome development. Ophthalmic, orthopaedic, and child guidance clinics should provide close links between health, education, and hospital committees.

The Ministry of Health and Local Government is given wide powers of co-ordination under the Welfare Service and Health Service Acts.

Under the new Health Services Act (Northern Ireland), 1953, the Minister is given new powers to require from the statutory bodies proof of due performance of certain functions under the Health Services and Tuberculosis Acts.

The benefits of the Health Service are made available to citizens of the United Kingdom generally, and can be made available to other non-residents subject to such exceptions as may be described, "in accordance with a scale of charges" approved by the Ministry.

As far as officers employed in the General Service are concerned, reciprocity of superannuation exists for those in the General Health Services and also for Local Government officers under the Local Government Superannuation Act (Northern Ireland), 1950.

Slight differences of administration exist, but, these apart, it could truly be said that any resident of great Britain coming to live in Northern Ireland would notice very little difference in the availability of services.

SUMMARY

A very brief description has been attempted of the Medical Services of Northern Ireland, with special reference to differences between them and similar services in Great Britain.

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REVIEW OF 8,000 CASES OF PNEUMONIA ADMITTED TO DUDLEY ROAD HOSPITAL, BIRMINGHAM (1934–38 AND 1944–48)

BY

VERA NORRIS

*From the Department of Medical Statistics, University of Birmingham, and Birmingham Regional Hospital Board**

1. INTRODUCTION

This study was initiated primarily to discover what use could be made of routine medical records kept in a large general hospital. The Dudley Road Hospital, Birmingham, has for many years maintained a diagnostic index which records the following facts for each discharge or death: *diagnosis*, *age*, *sex*, *dates of admission and discharge*, *complications*, *disposal*, and *case reference number*. Attention was focused on admissions referable to pneumonia because it is one of the commonest reasons for hospital admission, and methods of treatment have changed dramatically during the past 15 years. The inquiry takes within its scope records of two quinquennia, 1934–38 and 1944–48; these were chosen because:

(*a*) sulphonamide therapy was not yet in general use during the first period;

(*b*) singly or jointly, drugs of the sulphonamide group and antibiotics had become the standard treatment for cases of this sort during the second period.

The ensuing study is not in the fullest sense of the term a "clinical trial" since it was not feasible to ensure matching of cases with regard to conditions relevant, or possibly relevant, to treatment efficacy. None the less, it should be illuminating if only as a historical review of the treatment of the pneumonia over the last two decades. The historical control (Hill, 1951; Hogben and Wrighton, 1952) has admittedly and rightly been a target of criticism; but it may happen to be the only method of comparison feasible in a field in which ethical as well as practical difficulties beset the theoretically desirable task of subjecting the use of every new drug to a rigorously controlled experiment. Such difficulties are often surmountable when a new drug is available at first only in very small quantities. In such a situation, selection of test cases is inevitable, and the dictates of the ideally controlled clinical trial confront the doctor with no dilemma; but the professional code of the physician can accommodate them less congenially if a drug of reputedly life-saving qualities is initially obtainable in adequate supply. However defective the historical method may be, it is still the only one available for assessment of the value of therapies already included in the physician's armamentarium before current standards with regard to the conduct of clinical trials had been accepted; and in that context it has a limited usefulness if applied with judicious recognition of its shortcomings. Its shortcomings are indeed formidable, when the topic involves the infections. Comparison of therapies referable to two eras is open to the particular objection that the virulence of the infecting micro-organisms is known to be variable. Until the advent of the sulphonamides, the annual case mortality from lobar pneumonia varied between 20 and 30 per cent. or an even higher figure (Cecil, 1940).

Since the introduction of sulphonamide therapy for pneumonia there have been numerous small scale surveys of treated cases, including those of Evans and Gaisford (1938), Flippin and others (1943), Kraus (1947), and Lewis (1948). In addition, Stahle (1942) has made a large survey of 15,000 cases in American hospitals. What follows is a comparable study of the experience of an English hospital. Our yardsticks of treatment efficacy are:

(*a*) case *mortality* rates;

(*b*) average *duration of stay in hospital*;

(*c*) incidence of *empyema*.

The treatment procedures examined are the various sulpha-drugs and antibiotics. The diagnostic index, mentioned earlier, provided source material for a pilot survey to ascertain information about criteria of treatment efficacy and also about the relevant age and sex distributions of cases. The number of admissions for pneumonia in the 10 years selected was 8,109, and recourse to punch-card machinery made the analysis of the results referable to so large a sample practicable. The same

*Now at the Institute of Psychiatry, University of London, Maudsley Hospital, London.

machinery tabulated total figures for duration of stay for each sub-class of cases. In the pilot survey it was not possible to analyse the data by treatment, since the diagnostic index does not specify the therapy; but the outcome, embodied in Tables I to VI, is at least suggestive, if only by disclosing striking differences between hospitalization of pneumonias in the 1930s and in the 1940s.

2. Results of the Pilot Survey

In age groups other than those of children less than 10 years old, there was a notable reduction of case mortality associated with *lobar* pneumonia in the 1940s (Table I); and the differences are too great to be due to chance if we adopt current standards of significance ($P<0{\cdot}0001$). Contrariwise, there was no great reduction of mortality associated with broncho-pneumonia. Indeed, in some instances, the mortality rates in the second period were higher than in the 1930s. The only noteworthy exception to the preceding statement is that reduction in the mortality rate for women aged 60 or more was highly significant.

TABLE I
MORTALITY RATES AMONG HOSPITALIZED CASES

Type of Disease	Sex	Age Group	1934–38		1944–48	
			No. of Cases	Mortality per cent.	No. of Cases	Mortality per cent.
Lobar Pneumonia	Male	Under 10	407	3·9	598	3·7
		10–39	846	16·0	439	3·0
		40–59	450	39·1	442	15·4
		60 and over	102	60·8	248	28·2
		All ages	1,805	21·6	1,727	10·0
	Female	Under 10	235	6·8	485	10·7
		10–39	365	14·2	327	3·4
		40–59	175	31·4	190	6·8
		60 and over	83	69·9	135	18·5
		All ages	858	21·1	1,137	8·9
Broncho-pneumonia	Male	Under 10	594	23·7	240	30·0
		10–39	144	31·2	25	44·0
		40–59	216	52·3	69	50·7
		60 and over	124	73·4	60	61·7
		All ages	1,078	36·2	394	39·3
	Female	Under 10	506	22·1	207	22·2
		10–39	76	23·7	25	20·0
		40–59	111	41·4	34	35·3
		60 and over	92	65·2	59	44·1
		All ages	785	30·1	325	27·4

Duration of stay in hospital (Tables II and III) was separately calculated for non-fatal cases, uncomplicated and complicated. The fatal cases were excluded, because seriously ill patients often died on the day of admission or shortly afterwards, whence a group with a high mortality might give a falsely favourable average stay. The duration of stay for patients in each age group, except the over-60's and for both lobar and broncho-pneumonia, was very much lower in the period 1944–48 than in 1934–38. The average difference for men suffering from lobar pneumonia was 3·8 days and for women 6·2 days; the difference for males and females suffering from broncho-pneumonia was 5 days. These differences were highly significant, the probability that they would occur in random sampling being less than 1 in 10,000. For men and women over 60 suffering from lobar pneumonia, the difference was not statistically significant. Duration of stay for non-fatal cases of lobar pneumonia with complications fell by almost 50 per cent. in the period here dealt with. For broncho-pneumonia

TABLE II
DURATION OF STAY IN HOSPITAL OF UNCOMPLICATED NON-FATAL CASES

Type of Disease	Sex	Age Group	1934–38		1944–48	
			No. of Cases	Average Stay (days)	No. of Cases	Average Stay (days)
Lobar Pneumonia	Male	Under 10	342	20·76	496	15·44
		10–19	212	18·60	114	18·39
		20–29	206	20·32	104	15·65
		30–39	218	21·98	164	17·60
		40–49	152	23·15	172	18·57
		50–59	89	23·94	137	20·77
		60 and over	35	27·71	131	20·69
		All ages	1,254	21·24	1,318	17·47
	Female	Under 10	183	21·47	378	14·32
		10–19	103	19·96	75	16·40
		20–29	87	22·24	95	14·56
		30–39	91	21·14	100	17·00
		40–49	61	26·44	65	18·34
		50–59	37	24·13	68	18·46
		60 and over	24	29·46	87	20·10
		All ages	586	22·28	868	16·04
Broncho-pneumonia	Male	Under 10	372	22·9	137	15·7
		All ages	539	22·5	179	17·4
	Female	Under 10	337	21·8	127	16·6
		All ages	439	22·6	171	17·4

TABLE III
DURATION OF STAY (IN DAYS) IN HOSPITAL OF NON-FATAL CASES WITH COMPLICATIONS

Type of Disease	Sex	1934–38		1944–48	
		No. of Cases	Average Stay	No. of Cases	Average Stay
Lobar Pneumonia	Male	177	53·2	237	28·7
	Female	79	55·7	167	30·8
Broncho-pneumonia	Male	153	36·7	60	24·2
	Female	108	35·4	66	23·4

the reduction was to the one-third level. We may regard both differences as highly significant in the customary sense of the term.

Percentage incidence of complicated cases was also a subject of comparison for the same two periods. For the purposes of the pilot study we define as *complications* any conditions likely to affect adversely the average duration of stay or the case fatality rates. Therefore complications directly attributable to the pneumonias and concomitant conditions, such as chronic bronchitis, heart disease, fibrosis of the lungs, and so on, were both included. The incidence of complications for all types of cases (Table IV) rose slightly during the second period; and the difference is statistically significant for males suffering from lobar pneumonia, a circumstance which suggests that favourable results in the second quinquennium were *not* due to admission of cases less serious than those admitted in the preceding one. Indeed, it is likely that in the second period, only the more seriously ill patients were admitted to hospital, because the introduction of sulpha-drugs had made it possible for the general practitioner to treat the mild cases in their own homes with more assurance; the two age distributions reinforce this suggestion.

TABLE IV
INCIDENCE OF COMPLICATIONS

Type of Disease	Sex	1934–38		1944–48	
		No. of Cases	Complications per cent.	No. of Cases	Complications per cent.
Lobar Pneumonia	Male	1,805	14·0	1,727	17·6
	Female	858	15·7	1,137	18·3
Broncho-pneumonia	Male	1,078	32·0	394	34·0
	Female	785	28·7	325	30·1

Considerable differences between the age distributions of cases distinguish these two periods (Table V). In 1944–48, there is a higher proportion of persons in the age groups *under 10* and *60 and over*, and the differences are highly significant ($P<0·0001$). Since pneumonia is apt to be more formidable in these age groups, we might expect *ceteris paribus* more unfavourable results in the second than in the first period.

The incidence of empyema as a complication of lobar pneumonia (Table VI) fell from 4·4 per cent. in the first period to 0·8 per cent. in the second, a highly significant difference. Cecil (1940) cites for pneumococcal pnuemonia treated in the Bellevue Hospital, New York, an empyema incidence of 5·1 per cent. before the introduction of sulpha-drugs. In the cases which this survey covers, the incidence of empyema associated with broncho-pneumonia was 1·2 per cent. in the earlier group; and there was no case with empyema recorded in the second period.

TABLE VI
INCIDENCE OF EMPYEMA

Type of Disease	1934–38		1944–48	
	No. of Cases	Per cent. Empyema	No. of Cases	Per cent. Empyema
Lobar Pneumonia	2,663	4·4	2,864	0·8
Broncho-pneumonia	1,863	1·2	719	—

While it is not unreasonable to attribute remarkably favourable results in the second period to the effect of modern therapies including both sulphonamides and anti-biotics, it would not be justifiable to proffer the results of this preliminary study as conclusive evidence to that effect; but the results encouraged the hope that it might well be profitable to bring within the scope of the enquiry more specific information about the relative merits of the several therapies employed. This involved inspection of the individual case records. In view of the additional labour entailed, it was necessary to curtail the size of the sample by dealing only with admissions in the years 1934, 1936, and 1938 (hereafter designated *Period A*), and 1944, 1946, and 1948 (*Period B*).

TABLE V
PERCENTAGE AGE DISTRIBUTION OF CASES

Type of Disease	Period	Males				Females			
		Under 10	10–39	40–59	60 and over	Under 10	10–39	40–59	60 and over
Lobar Pneumonia	1934–38	22·6	46·9	24·9	5·5	27·4	42·6	20·4	9·6
	1944–48	34·6	25·4	25·6	14·4	42·6	28·7	16·7	12·0
Broncho-pneumonia	1934–38	55·1	13·4	20·0	11·5	64·5	9·7	14·1	11·7
	1944–48	60·9	6·3	17·5	15·3	63·7	7·7	10·5	18·1

3. Examination of Individual Case Records

By reference to the diagnostic index, the case notes appropriate to each case of pneumonia were summarized on a form suitably designed for punch card analysis. From perusal of the case records, it was not always possible to complete the form entirely. In a high proportion of cases (80 per cent.), there was no information about whether the patient had received any sulpha-drugs or penicillin *before* admission; but, in Period *B*, 248 cases of lobar pneumonia, 45 cases of broncho-pneumonia, and eight cases of pneumonia not otherwise specified had explicitly received some form of specific treatment before admission. Unfortunately likewise, information with respect to drug reactions was scanty. The case records show that four males out of 309 treated with sulphapyridine in Period *A* had toxic reactions interfering with the course of therapy (two anaphylaxis, two toxic cyanosis), and that four females out of 162 treated with this drug also had reactions (two anaphylaxis, one toxic cyanosis, one severe vomiting). Of those patients in Period *B* treated with sulpha-drugs, eleven males out of 766 had reactions recorded (nine anaphylaxis, one severe vomiting, one other), and three females out of 463 (all anaphylaxis). Two males receiving penicillin suffered from anaphylaxis, but no women had reactions to this drug. Of males treated with both penicillin and sulpha-drugs only one had an anaphylactic reaction, but seven females reacted unfavourably (two anaphylaxis, one drug fever, one renal symptoms, one agranulocytosis, one other). It is not possible to say with confidence that the above include all the patients who reacted unfavourably to treatment. On the contrary, it is likely that some such went unrecorded. Gaisford (1939) noted that there were few serious complications in his series of 400 cases treated by sulphapyridine. Inspection of the temperature chart was undertaken whenever this document was filed with the case record. A sudden drop of temperature was defined as a drop of at least 2 degrees in 24 hours. In the detailed study a distinction was made between *concurrent conditions* (*i.e.* conditions co-existing with pneumonia and often present before its onset) and *complications* (*i.e.* conditions arising as a result of pathological changes due to pneumonia).

Table VII shows the types of pneumonia cases admitted in the two periods. In both there was a preponderance of lobar pneumonia. The proportion of broncho-pneumonia decreased considerably in Period *B*; but it is probable that many cases of secondary broncho-pneumonia were listed in the index under the designation of the condition for which they were first admitted to hospital, and are hence not included in what follows. We here deal only with cases specified as such in the diagnostic index under code numbers 490–493 (International Statistical Classification, 1948).

Treatments Adopted.—The treatments adopted for all types of pneumonia are shown by year in Table VIII (overleaf). The Dudley Road Hospital adopted sulphapyridine treatment at an early date, and two medical consultants made a clinical trial in which the efficacy of this drug was assessed (Evans and Gaisford, 1938). They found that the case mortality of lobar pneumonia treated with sulphapyridine was 8 per cent. as against 27 per cent. for a matched control group observed at the same time. Among 100 patients treated, sixty had a sharp drop of temperature within 48 hrs, whereas this happened in only 34 of the same number of controls; the difference, 26 per cent., is highly significant (standard error 3·5 per cent., $P<0·0001$). These authors did not compare the incidence of complications or the duration of stay for treated and control patients, but the writer has since obtained some relevant information to be considered later.

In spite of the spectacular effect of sulphapyridine in the treatment of lobar pneumonia, this drug was

TABLE VII
DISTRIBUTION OF ADMISSIONS BY DIAGNOSIS

Diagnosis		1934, 1936, 1938				1944, 1946, 1948			
		Males		Females		Males		Females	
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Lobar pneumonia	Typed	97	5·3	44	4·3	10	0·8	8	1·0
	Untyped	949	50·9	432	42·1	996	76·8	564	69·6
Broncho-pneumonia	Primary	628	33·7	435	42·4	202	15·5	177	21·9
	Secondary	64	3·5	56	5·4	37	2·9	24	3·0
Pneumonia (unspecified)		124	6·6	60	5·8	52	4·0	37	4·5
All Admissions		1,866	100·0	1,027	100·0	1,297	100·0	810	100·0

TABLE VIII

TREATMENT OF ALL CASES OF PNEUMONIA BY YEAR OF ADMISSION

Therapy	Period A								Period B							
	1934		1936		1938		Total		1944		1946		1948		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
No specific therapy	951	99·8	766	99·7	638	55·1	2,355	81·8	84	11·4	80	11·5	57	8·4	221	10·5
Sulphanilamide ..									6	0·8					6	0·3
Sulphapyridine ..					468	40·4	468	16·2	3	0·4					3	0·1
Sulphadiazine ..									83	11·3	53	7·6			136	6·5
Sulphathiazole ..									20	2·7	9	1·3	1	0·1	30	1·4
Sulphamezathine ..									514	69·8	379	54·5	161	24·0	1,054	50·1
Penicillin alone ..											61	8·8	179	26·6	240	11·4
Penicillin and sulpha-drugs ..											113	16·2	274	40·9	387	18·4
Other treatment ..	2	0·2	2	0·3	52	4·5	56	2·0	26	3·6	1	0·1			27	1·3
All Admissions	953	100·0	768	100·0	1,158	100·0	2,879	100·0	736	100·0	696	100·0	672	100·0	2,104	100·0

TABLE IX

TREATMENT RELATED TO TYPE OF PNEUMONIA

Therapy	Lobar Pneumonia				Broncho-pneumonia				Pneumonia (unspecified)			
	Period A		Period B		Period A		Period B		Period A		Period B	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
No specific therapy ..	1,171	76·7	131	8·3	1,052	88·9	68	15·4	145	78·8	22	24·8
Sulphapyridine ..	331	21·7	1		103	8·7	1	0·2	34	18·5	1	1·1
Sulphadiazine ..			118	7·5			17	3·9			1	1·1
Sulphamezathine ..			858	54·4			150	34·2			48	53·9
Other sulpha-drugs ..			21	1·3			15	3·4				
Penicillin alone ..			148	9·4			85	19·3			7	7·9
Penicillin and sulpha-drugs ..			285	18·1			95	21·6			8	9·0
Other treatment ..	24	1·6	16	1·0	28	2·4	9	2·0	5	2·7	2	2·2
All Admissions	1,526	100·0	1,578	100·0	1,183	100·0	440	100·0	184	100·0	89	100·0

soon superseded by others less toxic. In Period *B*, sulphamezathine was the drug of choice, and was used for over half of the cases. The years covered by this study also saw the introduction of penicillin; this was used to only a small extent in 1946, but in 1948, either alone or in conjunction with sulpha-drugs, it was used in two-thirds of the cases. From Table IX we see that penicillin was used for 41 per cent. of the cases of broncho-pneumonia, but in only 27·5 per cent. of those of lobar pneumonia. Although over 80 per cent. of patients treated with sulpha-drugs suffered from lobar pneumonia, the same is true of only 62 per cent. of the penicillin group.

Age and Sex Distribution.—An examination of the age and sex distribution of the cases of the three types of pneumonia, discloses a familiar age difference between lobar and broncho-pneumonia. There is a significant preponderance of females of less than 5 years of age over males in that group, but a sex difference was not apparent among elderly people aged over 65 years. For both sexes and for both lobar and broncho-pneumonia there were significantly higher proportions of the elderly in Period *B* ($P<\cdot01$) and for lobar pneumonia there was a significant excess ($P<\cdot001$) of patients under 5 years old in Period *B*. We have seen (Section 2) that this is suggestive. Since pneumonia is a more serious illness at these ages, the age distribution biases the sample in favour of more *unfavourable* results in Period *B*.

Effect of Treatment on Duration of Stay in Hospital.—For a reason already stated, it is desirable to exclude fatal cases when considering duration of stay. The proportion of persons dying within 20 days varies considerably (Table X, opposite). A great many deaths occur on the day of admission and this will obviously invalidate duration-of-stay figures from which deaths are not excluded. When we exclude deaths, we find that a much higher proportion of males treated with sulphapyridine are discharged within 20 days and that the difference is highly significant. Among females, the excess of early discharge among sulpha-treated patients is not significant. In Period *B* we find that there are a number of variations between the proportion of early discharges in the diverse treatment groups. Such differences are highly significant. It is not

TABLE X

PROPORTION OF PATIENTS WHO DIED OR WERE DISCHARGED WITHIN 20 DAYS OF ADMISSION

Period	Sex	Therapy	Total No. of Cases	Deaths within 20 days		Total No. of Discharges	Discharges within 20 days	
				No.	Per cent.		No.	Per cent.
A	Male	No specific therapy	1,533	385	25·1	1,148	534	46·5
		Sulphapyridine	209	29	13·9	280	171	61·1
	Female	No specific therapy	838	184	22·0	654	293	44·8
		Sulphapyridine	162	14	8·6	148	77	52·0
B	Male	No specific therapy	138	44	31·9	94	60	63·8
		Sulpha-drugs	766	87	11·4	679	490	72·2
		Penicillin alone	130	29	22·3	101	72	71·3
		Penicillin and sulpha-drugs	245	43	17·6	242	122	50·4
	Female	No specific therapy	83	22	26·5	61	38	62·3
		Sulpha-drugs	465	14	3·0	451	357	79·2
		Penicillin alone	110	33	30·0	77	51	66·2
		Penicillin and sulpha-drugs	143	16	11·2	127	74	58·3
A	Male	No specific therapy	1,148	385	25·1	1,148	534	46·5
B			138	44	31·9	94	60	63·8
A	Female	No specific therapy	838	184	22·0	654	293	44·8
B			83	22	26·5	61	38	62·3

surprising to find that persons receiving both penicillin and sulpha-drugs have the lowest proportion of early discharges, since it was common practice to prescribe a second drug only after the first one used had failed to improve the patient's condition. Similarly, one would expect to find a greater number of early discharges in Period *B* among patients who received no specific treatment than among such patients in Period *A*, since it is safe to assume either of two possibilities with respect to patients receiving no specific treatment in the latter period:

(*a*) they were not very sick;
(*b*) the diagnosis was in doubt.

Tables XI and XII show figures for average duration of stay. Since the duration of stay of non-fatal cases of pneumonia ranged from 2 or 3 days to over 300 days, it is not surprising to find that there are few differences between the means of various groups, since a small number of cases with excessively long durations would bias adversely the average stay figures. In the pilot study, it was possible to deal separately with complicated and uncomplicated cases. Since the cases with a very long stay usually suffered from some complication (notably empyema), the range of uncomplicated cases was not so extreme. In many ways, therefore, the preceding comparison between proportions of early discharges is a better guide to comparative duration of stay figures than the average stay. Table XI exhibits a comparison of the average stay of sulphapyridine-treated cases of lobar pneumonia in 1938, and that of others who received no specific treatment. There are no significant differences for any of the age and sex groups examined. Table XII shows the average stay of non-fatal cases of lobar pneumonia treated by various drugs in Period *B*. An examination of the differences between therapies was made by recourse to the analysis of variance. For several groups the

TABLE XI

AVERAGE DURATION OF STAY OF NON-FATAL CASES OF LOBAR PNEUMONIA, 1938

Sex	Age Group	No Specific Therapy		Sulphapyridine	
		n	Mean Stay (days)	*n*	Mean Stay (days)
Male	Under 10	29	22·9±3·30	48	22·3±3·59
	10–39..	78	19·8±1·94	97	23·9±1·96
	40–59..	30	24·4±2·94	54	27·8±2·55
	60 and over	5	24·6±5·20	7	39·4±17·60
Female	Under 10	18	23·3±4·17	27	25·5±3·59
	10–39..	36	20·4±1·56	47	29·4±4·92
	40–59..	14	28·3±6·11	17	28·8±4·26
	60 and over	4	16·7±4·39	6	21·7±3·03

TABLE XII

COMPARISON OF THE AVERAGE DURATION OF STAY (IN DAYS) OF NON-FATAL CASES OF LOBAR PNEUMONIA IN PERIOD B

Sex	Age Group	Sulpha-methazine	Sulpha-diazine	Penicillin alone	Penicillin and Sulpha-drugs
Male	Under 10	16·1	15·7	17·4	16·5
	10–39..	18·7	17·3	21·9	18·6
	40–59..	20·2	24·2	22·3	22·2
	60 and over	19·3	24·5	16·0	29·5
Female	Under 10	15·6	12·7	13·6	19·7
	10–39..	16·7	15·5	17·6	16·3
	40–59..	17·5	13·6	28·0	24·4
	60 and over	17·5	24·7	22·5	24·5

within-sample variation is so great as to overshadow any *between-sample* variation. Among males over 60 years the duration of stay of penicillin-treated cases is lower than in any other group; sulphamezathine-treated cases record the next most favourable result, and the *between-sample* variation is significantly large. Two female age groups, 10–39 and 40–59 years, show significantly large *between-sample* variations. In each of these, sulphadiazine-treated patients have the shortest stay and sulphamezathine gives the next best result; but it is not possible to interpret these differences with great confidence, since it is likely that there was some selection of patients for the various therapies; and our crude figures throw no light on this possibility.

Comparison of Incidence of Complications between Periods A and B.—For both lobar and broncho-pneumonia the incidence of complications is higher in the second period, but the types of complications experienced are very different (Table XIII). In lobar pneumonia the incidence of empyema dropped from 7·5 per cent. in Period *A* to 1·4 per cent. in Period *B* and this difference is highly significant. The incidence of pleurisy with and without effusion was only 3·6 per cent. in Period *A* compared with 7·9 per cent. in Period *B*, and this difference too is highly significant ($\chi^2=112$, $P<0{\cdot}0001$). If we regard empyema and pleural effusion as stages in the same pathological process, we can see whether or not there is any difference in the incidence of empyema and pleurisy together in the two periods. During Period *A*, the two complications occur in 11 per cent. cases of lobar pneumonia and during Period *B* in 9·3 per cent. cases; but the difference is not significant ($\chi^2=2{\cdot}8$, $P>0{\cdot}05$). It might thus seem that modern therapy has had the effect of sterilizing the fluids exuded into the pleural cavity rather than of radically altering the pathological processes involved. Another remarkable difference with respect to experience of complications in the two periods is that the incidence of meningitis associated with broncho-pneumonia has fallen from 9·4 per cent. in Period *A* to 3·6 per cent. in Period *B* ($\chi^2>10{\cdot}827$, $P<{\cdot}001$).

Table XIV (opposite) shows the incidence of complications in cases of lobar pneumonia in Period *B*. The figures for individual complications are too small to illustrate any statistically significant differences. On the whole, penicillin-treated cases are associated with a higher incidence of complications. It is true that patients admitted with complications might have been given penicillin in preference to sulphamezathine; but this would hardly account for the higher (albeit statistically insignificant) incidence of empyema which must be a rare complication to find *on admission*. The rates for patients treated with both penicillin and sulpha-drugs are explicably higher, since the inception of a complication is a common enough indication for a change in treatment. In all treatment groups together, males have a significant preponderance of complicated cases over females. In the sulphamezathine- and penicillin-treated groups, males have an excess of complications, but in the group of patients receiving both penicillin and sulpha-drugs females have an excess of complications.

Temperature Reaction by Diagnosis and Period.—As observed earlier by Evans and Gaisford (1938) there was a highly significant excess in Period *B* of patients whose temperature dropped suddenly

TABLE XIII

INCIDENCE OF DIFFERENT TYPES OF COMPLICATIONS IN PERIODS A AND B

Complication	Lobar Pneumonia				Broncho-pneumonia				Pneumonia (unspecified)			
	Period A		Period B		Period A		Period B		Period A		Period B	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent	No.	Per cent.
None	1,159	76·0	1,147	72·7	860	72·7	345	78·4	115	62·5	67	75·3
Empyema without rib resection	36	2·5	9	0·6	12	1·0	5	1·1	9	4·9	1	1·1
Empyema with rib resection	77	5·0	12	0·8	14	1·2	—	—	21	11·4	1	1·1
Pleural effusion	37	2·5	99	6·3	—	—	—	—	5	2·7	2	2·2
Pleurisy without effusion	17	1·1	25	1·6	5	0·4	7	1·6	3	1·6	—	—
Delayed resolution	46	3·0	58	3·7	9	0·8	2	0·4	5	2·7	3	3·4
Atelectasis	1	—	34	2·0	32	2·7	5	1·4	—	—	—	—
Otitis media	42	2·7	31	2·0	2	0·2	2	0·4	9	4·9	1	1·1
Meningitis	·2	0·1	—	—	111	9·4	16	3·6	1	0·5	—	—
Others	109	7·1	163	10·3	138	11·6	58	13·2	16	8·8	14	15·8
All Complications	1,526	100·0	1,578	100·0	1,183	100·0	440	100·0	184	100·0	89	100·0

TABLE XIV

INCIDENCE OF COMPLICATIONS OF LOBAR PNEUMONIA IN PERIOD B RELATED TO TREATMENT

Sex	Complications	Sulphamezathine		Penicillin alone		Penicillin and Sulpha-drugs	
		No.	Per cent.	No.	Per cent.	No.	Per cent.
Male	None	436	78·2	47	61·0	115	63·2
	Empyema (all cases)	7	1·3	3	3·9	2	1·1
	Pleurisy and pleural effusion	44	7·8	6	7·8	18	9·9
	Delayed resolution	17	3·0	2	2·6	12	6·6
	Atelectasis	7	1·3	6	7·8	7	3·8
	Others	47	8·4	13	16·9	28	15·4
	Total Treated Cases	558	100·0	77	100·0	182	100·0
Female	None	249	84·1	42	65·7	49	50·5
	Empyema (all cases)	—	—	2	3·1	2	2·1
	Pleurisy and pleural effusion	9	3·1	4	6·2	14	14·4
	Delayed resolution	6	2·0	2	3·1	—	—
	Atelectasis	4	1·3	3	4·7	4	4·2
	Others	28	9·5	11	17·2	28	28·8
	Total Treated Cases	296	100·0	64	100·0	97	100·0

TABLE XV

TEMPERATURE DROP BY DIAGNOSIS AND PERIOD

Sudden Drop of Temperature	Lobar Pneumonia				Broncho-pneumonia				Pneumonia (unspecified)			
	Period A		Period B		Period A		Period B		Period A		Period B	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
No sudden drop	437	28·6	309	19·6	395	33·4	175	39·8	55	29·9	29	32·6
Within 1 day	178	11·7	376	23·8	108	9·2	89	20·2	25	13·6	23	25·8
Within 2 days	204	13·4	378	23·8	78	6·6	47	10·7	17	9·2	15	16·8
Within 4 days	239	15·7	200	12·6	94	7·9	19	4·3	23	12·5	6	6·7
Within 6 days	116	7·6	53	3·6	55	4·6	5	1·1	4	2·2	1	1·2
Within 7 or more days	37	2·4	25	1·6	29	2·5	4	0·9	2	1·1	—	—
Not specified	315	20·6	237	15·0	424	35·8	101	23·0	58	31·5	15	16·9
All Admissions	1,526	100·0	1,578	100·0	1,183	100·0	440	100·0	184	100·0	89	100·0

TABLE XVI

MORTALITY RATES (M.R.) IN CASES OF LOBAR PNEUMONIA

Period	Therapy	Age of Patient (years)							
		Under 10		10–39		40–59		60 and over	
		No. of Cases	M.R. per cent.	No. of Cases	M.R. per cent.	No. of Cases	M.R. per cent.	No. of Cases	M.R. per cent.
1938	Sulphapyridine	50	4·0	98	1·0	60	10·0	14	50·0
	No specific treatment	30	3·3	94	17·0	59	49·1	18	28·0
	Total Cases	80	3·7	192	8·9	119	29·6	32	37·5
Period B	Sulphamezathine	281	3·2	269	1·1	200	8·5	104	22·1
	Penicillin alone	60	8·3	30	3·3	26	19·2	25	36·0
	Penicillin and sulpha-drugs	115	5·2	70	5·7	59	16·9	35	25·7
	Total Cases	456	4·4	369	2·2	285	11·2	164	25·0

within 48 hrs (Table XV). There was also in Period *A* a higher proportion of patients with lobar pneumonia who had no sudden drop in temperature. The differences exhibited in Table XV are highly significant. For both lobar pneumonia and broncho-pneumonia $\chi^2=23$, $P<0{\cdot}00001$.

Case Mortality Rates of Lobar Pneumonia by Treatment and Age.—Table XVI shows age-specific case mortality rates. Among patients admitted in 1938 between the ages of 10 and 59 years there was a great reduction in mortality in the group treated with sulphapyridine. For untreated cases, the case mortality for those aged 10–39 years was 16 per cent. higher than for treated cases. The difference was 39 per cent. in patients aged 40–59 years. Both these differences are highly significant. There was no significant difference between mortality rates of

TABLE XVII

AGE AND SEX DISTRIBUTION OF DEATHS AMONG CASES OF LOBAR PNEUMONIA IN PERIOD B

Sex	Therapy	Age of Patient (years)							
		Under 10		10–39		40–59		60 and over	
		No. of Cases	M.R. per cent.	No. of Cases	M.R. per cent.	No. of Cases	M.R. per cent.	No. of Cases	M.R. per cent.
Male	Sulphamezathine	168	4·2	174	1·1	144	13·9	72	26·5
	Penicillin alone	31	6·4	16	—	13	23·0	17	41·2
	Penicillin and sulpha-drugs	74	5·4	45	6·7	39	23·0	24	16·7
	Others	16	6·2	19	10·5	25	20·0	4	50·0
	Total Cases	289	4·8	254	2·7	221	16·7	117	27·3
Female	Sulphamezathine	113	1·8	95	1·6	56	8·9	32	12·5
	Penicillin alone	29	10·8	14	7·1	13	15·4	8	25·0
	Penicillin and sulpha-drugs	41	4·9	25	4·0	20	5·0	11	45·5
	Others	17	—	24	—	9	—	4	—
	Total Cases	200	3·5	158	1·9	98	9·2	55	20·0

treated and untreated patients aged less than 10 years or over 60 years. In Period *B* the case mortality rates for each of three treatment groups have been compared, and in each group sulphamezathine has the lowest mortality. Except for the age group 10–39 years, cases treated with penicillin alone had the highest mortality; but such differences are not statistically significant. In each age group the lobar pneumonia case mortality rate was higher for males than for females, but the differences were not large enough to be statistically significant.

Table XVII exhibits in greater detail mortality rates for lobar pneumonia in Period *B*. In each age group, males have a higher mortality rate than females. While none of these differences is large enough to be statistically significant, the trend is consistent. Similarly, we find that the mortality rates among lobar pneumonia cases treated with penicillin are greater than those treated with suphamezathine for all female age groups and for three out of four male age groups. Again, the differences in each age and sex group are too small to be significant; but the chance of getting seven out of eight results all pointing in the same direction is only 1 in 28, so that these results do suggest that penicillin-treated cases have a higher mortality than sulpha-treated cases. To what extent this may be due to selection of cases it is not possible to tell from the present study.

4. CONCLUSIONS

From this survey of patients admitted to hospital with *lobar* pneumonia it is admissible to infer that considerable advantages resulted from the use of sulphonamides and penicillin. In particular, the much lower mortality and empyema rates are challenging; but the shorter duration of stay in hospital is also noteworthy. Even now, many patients do not get full pay while off work on account of sickness, and a saving of several days is therefore of considerable economic benefit to the patient. From the viewpoint of the hospital service, the saving in bed-days is likewise by no means trivial.

If over 300 males and 200 females with lobar pneumonia annually receive treatment in Dudley Road Hospital, then the reduction in duration of stay is expressible as about 2,500 bed-days.

This means setting free, in this one hospital alone in the course of a single year, an average of seven beds for the treatment of other sickness. Presumably, therefore the introduction of modern therapies for pneumonia has greatly increased hospital facilities in England and Wales during the past two decades.

In a study such as this, it is not permissible to adjudicate upon the relative efficacy of the various drugs now used for treatment of the pneumonias. On the basis of such crude data, it is possible to testify with confidence only to the beneficial effects of the new therapies considered as a whole. With that reservation, the differences between hospital admissions in the 1930s and in the 1940s here demonstrated are so large as to leave little reasonable doubt that they are due to the availability of more efficient treatment in the second period. If one concedes the possibility that the differences might be partly due to changes in the virulence of pneumonia, one would expect that the clinical picture of the pneumonias would also have changed recognizably; but there is no shred of evidence in the data of this or of other studies to support such a contention.

Tentatively, our data tempt us to suggest as a theme for further inquiry the possible differences between the efficacy of sulphonamides and penicillin. They have indeed disclosed a differential response of the sexes to treatment. Thus females, in particular, did not respond so favourably to penicillin as to sulpha-drugs; but one must admit the possible existence of

a policy of releasing penicillin more freely for male patients, and restricting its allocation for the more seriously ill among females. Unless this is true, and it seems in fact unlikely, one must conclude that females react better to sulphonamides than to penicillin. Again, there may have been a disposition to restrict the prescription of penicillin to serious cases, as may well have been true in 1946; but it is less likely that this was so in 1948 when supplies of penicillin were plentiful. If not, our data give no support to the belief that penicillin-treated cases fare better than sulphonamide-treated patients.

The conclusion last and tentatively stated is of moment *vis à vis* the cost of treatment: that of a course of sulphamezathine for an average case of pneumonia being 7*s.* 8*d.* and that of a course of penicillin being 18*s.* 11½*d.* In this connexion it is interesting to cite the results of a clinical trial conducted by the Medical Research Council (1951) to assess three treatments for pneumonia: aureomycin, chloramphenicol, and *standard* (*i.e.* penicillin or sulphonamides), alone or in combination, and in whatever dosage the physician prescribed. In fact, only eight cases were found to have had sulphonamides alone. The different treatment groups were similar with respect to sex, age, anatomical location of the infection, day of illness admitted, temperature on admission, and number regarded as desperately ill on admission. The results, judged *inter alia* by the time taken for temperature to fall or for physical signs to disappear, and by length of stay in hospital, led to the conclusion that:

> for clinical pneumonia penicillin is at least as good as aureomycin or chloramphenicol. There are some indications that it may even be better.

This report cites the mean cost (as at September, 1951) of treatment with the three antibiotics as £10 1*s.* 6*d.* for aureomycin, £8 15*s.* 11*d.* for chloramphenicol, and 18*s.* 11½*d.* for penicillin. It is clear then that the cost of treatments with closely similar results can vary considerably. While it goes without saying that some patients may respond better, or only, to the more expensive drugs, in which event we are likely to regard the cost as a matter of subsidiary concern, we should be alert to the possibility that greater expense does not necessarily connote greater efficacy, if only because semi-educated public opinion responds all too readily to the appeal of rarity.

5. Summary

(1) An assessment is made of the treatment of pneumonias in a large General Hospital by recourse to routine data incorporated in the general diagnostic index and in individual case records of the patients. It covers two quinquennia, one in the 1930s and one in the 1940s.

(2) Analysis of the data referable to over 8,000 patients in the diagnostic index shows that there was a great reduction in:

(*a*) case *mortality* of lobar pneumonia;
(*b*) average *duration of stay in hospital*;
(*c*) incidence of *empyema.*

(3) A more detailed study based on a smaller sample of individual case records refers to admissions in the years 1934, 1936, 1938, and 1944, 1946, 1948. Sulphapyridine was the only sulphonamide in use during the earlier period, and a comparison of patients treated with it with patients who had no specific treatment discloses a large reduction in case mortality among treated cases. Among the former there was also a higher proportion discharged within 20 days of admission.

(4) In the later period, it is possible to compare results of using sulphonamides and antibiotics. Half the admissions in these three years were treated with sulphamezathine and 30 per cent. with penicillin either alone or in combination with a sulphonamide. In the second period, the progress of patients, as judged by mortality rates, duration of stay, incidence of empyema, and sudden rapid fall of temperature, was consistently much better than that of patients admitted in the 1930s.

(5) On the basis of the three-fold criterion of efficacy adopted, we can detect little difference between males treated with sulphonamides and those treated with penicillin; females seem to react more favourably to sulphonamide treatment than to penicillin.

(6) Reduction in the proportion of cases developing empyema in the second period was accompanied by an increase in the incidence of pleurisy with or without effusion.

(7) Since the introduction of sulphonamides and penicillin for the treatment of the pneumonias, the annual saving of bedspace in the hospital studied is estimated at about 2,500 bed-days, or an average of seven beds throughout the year.

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EPIDEMIOLOGY OF THE PSYCHOSOMATIC DISEASES

BY

M. D. WARREN

From the Public Health Department, Hampstead, and the London County Council.

The rise in deaths attributed to coronary thrombosis and duodenal ulcer has been widely commented upon. It has been suggested that these two conditions are merely examples of the psychosomatic diseases, the incidence of which has risen directly or consecutively with the rising mental stress associated with an increasingly complex civilization. In this paper certain epidemiological facts relating to selected examples of the psychosomatic diseases are studied, and it is shown that there are such differences in behaviour between the diseases as to suggest that modern civilization cannot adequately account for them.

A study of the many published case reports and clinical investigations leaves no doubt that mental stress plays a large part in precipitating individual attacks and causing exacerbations of the illnesses. Furthermore, mental stress will cause prolonged disability to arise from an illness which in a person with less stress would cause only temporary and trivial disability. If episodes of external stress acted universally in this way, then one would expect to see fluctuations in the incidence of the psychosomatic diseases related to periods of unemployment with more marked rises in the lower social classes, in towns subjected to bombing during the war, etc. Although Swinscow (1951) showed a correlation between suicides and unemployment no such correlations have been shown with the psychosomatic diseases.

For this study the following seven conditions have been selected as representative of the psychosomatic diseases:

(1) Asthma
(2) Thyrotoxicosis
(3) Hypertension—Cerebral haemorrhage—Myocardial degeneration
(4) Coronary artery disease—Coronary thrombosis
(5) Gastric ulcer
(6) Duodenal ulcer
(7) Rheumatoid arthritis

The figures for suicides are also compared. The above diseases have been accepted as psychosomatic by Dunbar (1943), Halliday (1949), and Weiss and English (1950). They have been selected for this study for the following reasons:

(*a*) Each can prove fatal and at least during the last 15 years has been recorded as a separate cause of death by the Registrar-General.

(*b*) Each is representative of one of the main systems of the body.

(*c*) Each is reasonably distinctive when florid and fully developed, and has been recognized as a clinical entity for at least 50 years.

The majority of the figures used are quoted or calculated from Tables given in the Registrar-General's Annual Statistical Reviews for England and Wales, and therefore refer only to mortality rates. Asthma and rheumatoid arthritis mortality figures can only represent a small proportion of the total incidence, and this must also apply to peptic ulcer figures. But in discussing secular trends and in making comparisons between sexes, classes, etc., there is no reason to presume that this difference between mortality and morbidity figures need invalidate the limited conclusions drawn.

However, in discussing the trends of mortality rates certain difficulties must be emphasized. They include the changes produced by the introduction of the new death certificate in 1927; the alteration in 1940 of the procedure used by the Registrar-General in deciding the principal cause of death where more than one cause was given; changes in the International Classification of Causes of Death; changing fashion and increased accuracy of diagnosis; the effect of improvements in therapeutics.

The difficulties in the interpretation of the occupational and social class incidence have been discussed in detail by Martin (1945). As the social classes are based on occupation the complications associated with occupational mortality must also be borne in mind. These are:

(1) Geographical limitation of the choice of occupation available. Genetic and family and social factors thereby become confused with occupational factors.

(2) Progression from menial occupations to executive occupations, so that the average age of the

latter will be higher than that of the former; similarly Social Classes I and II will contain a higher proportion of older people.

(3) Selection of an occupation for health reasons. Thus a person who is, or considers himself, "prone to rheumatism" will probably seek an indoor sitting-down job, as also would an asthmatic subject. An ambitious person brought up in a village will seek his career in the big towns. A person in poor health in the North of England may move to the South seeking more clement weather, and in so doing change his occupation. These considerations apply with equal force in discussing mortality figures for geographical areas. The degree of urbanization affects the social class structure. Thus large towns have the largest proportion of Social Classes IV and V, and the South of England has a high proportion of Class I since the Government and many large commercial firms have their executive and administrative staffs in London.

Statistical Data

The diseases are classified in the Figure and Tables in accordance with the Sixth Edition of the International Statistical Classification of Diseases, Injuries, and Causes of Death (1948). This edition, which differs considerably from previous editions, was adopted by the Registrar-General with effect from 1950. The diseases discussed below have the following classification numbers:

Asthma 240–241	Coronary disease 420
Thyrotoxicosis 252	Gastric ulcer 540
Hypertension 440–447	Duodenal ulcer 541
Cerebral haemorrhage 331	Rheumatoid arthritis 721–722

Suicide E970–E979

The comparative mortality indices referring to years before 1940 are in accordance with the previous classifications of the Registrar-General and are therefore not entirely comparable in size to the subsequent indices, but the pattern of incidence is still comparable. These remarks do not apply to myocardial degeneration; this has not been corrected to the sixth edition classification in which hypertension is shown as a separate cause of death for the first time. In order to gain a picture of hypertension before 1950 it has been necessary to consider the incidence of related conditions, and for this purpose cerebral haemorrhage, myocardial degeneration, and arteriosclerotic kidney are considered.

Secular Trends

The comparative mortality indices of the diseases under consideration are shown graphically in the Figure; the most striking feature being the continuous rise in deaths attributed to coronary artery disease and the fall in deaths since 1938 attributed to thyrotoxicosis. Another striking feature is the similarity in the patterns of incidence between the sexes.

The rise in deaths due to coronary artery disease has been remarked on by many authors. The Registrar-General discussed this in his reports for 1934, 1936, and 1938–9, and particularly considered whether the increase was real or was brought about artificially by a change in classification and certification. He concluded that:

> even if the whole of the increase in deaths attributed to coronary disease and angina pectoris has been due to a changing description of deaths formerly attributed to myocardial degeneration, with or without associated arteriosclerosis, the problem of the cause of the rapid increase for the combined group is still unsolved.

Since that time the increase has become even more rapid. Ryle and Russell (1949) made a statistical and clinical study of the recent trends in the incidence of coronary thrombosis and angina and also concluded that there was a definite and marked real increase in coronary artery disease. Morris (1951) also found, as a result of a careful study of necropsy reports at the London Hospital, that there had been a large increase in coronary artery disease. Logan (1952) also concluded that the increase was real.

The cause for the decrease in deaths attributed to thyrotoxicosis was discussed by the Registrar-General (1949), who stated:

> No satisfactory explanation for the rapid fall in mortality since 1938 has been suggested. The introduction of thiouracil on any sufficient scale to influence the death-rate came too late in the period under review to account for the fall. The surgical method of treatment had its greatest vogue before 1939.

The incidence of mortality due to asthma, cerebral haemorrhage, and cardiovascular degeneration (*i.e.* hypertension) has remained more or less steady, whilst that due to gastric ulcer and rheumatoid arthritis has decreased since 1940–41, having previously remained more or less stationary. The mortality due to duodenal ulcer increased for males in 1940; it remained higher in the following years, showing two periods of peak incidence in 1941 and 1945, and was again rising in 1950. For females the incidence showed a drop in 1942, a peak in 1945, and a sharp rise in 1949 and 1950. Suicides in males dropped during the war years, rose slightly in 1945–6, and since then has been more or less stationary. The females showed a similar drop in suicides during the war, but have shown a greater increase subsequently.

A further interesting feature of the Figure (opposite) is that all the causes of mortality other than suicide showed a peak incidence between 1939 and 1941, this being most marked in the case of asthma. The explanation of this peak is complex, for there was an increase in deaths from all causes

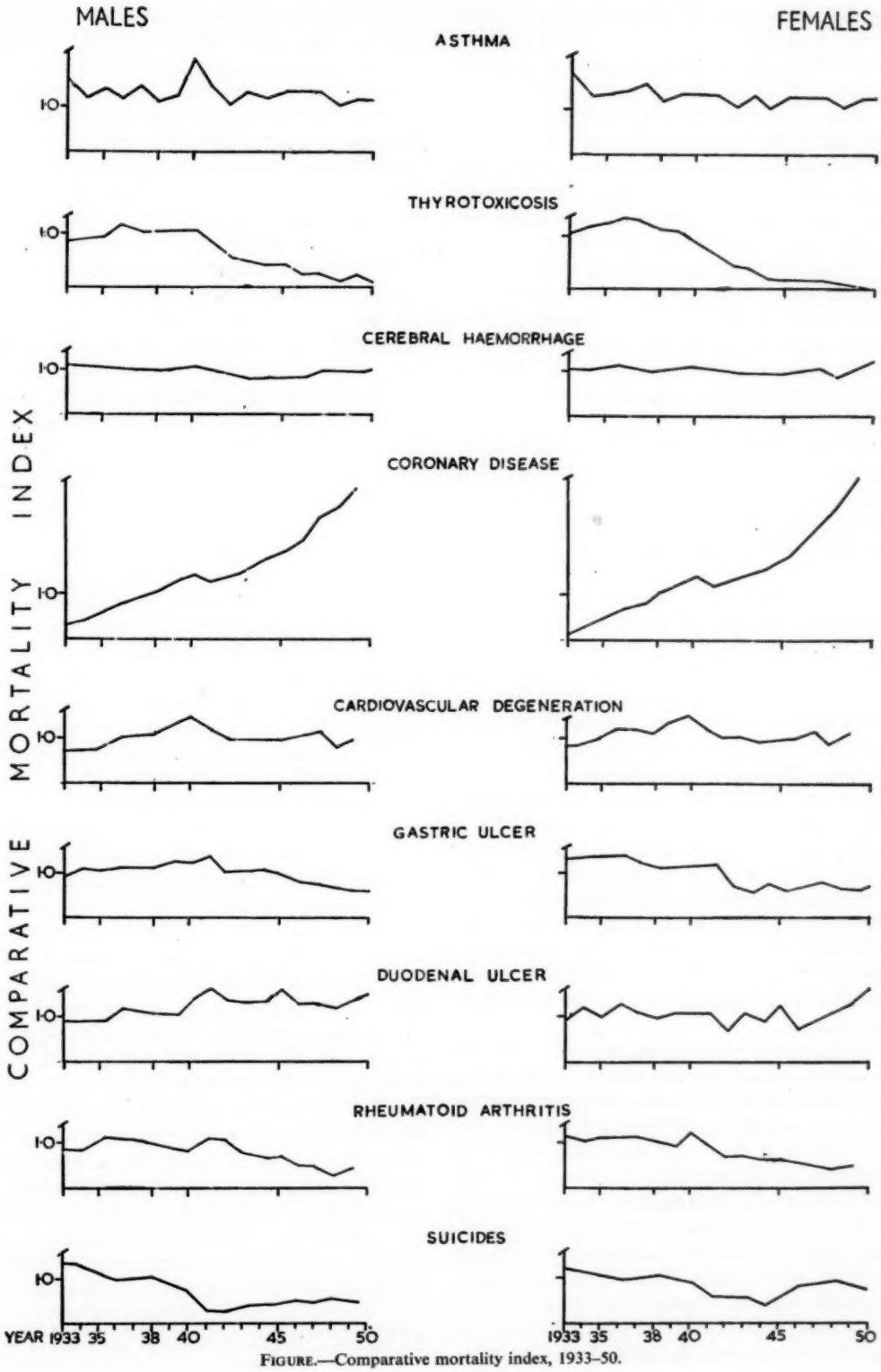

FIGURE.—Comparative mortality index, 1933–50.

in 1940, and the war-time figures referred to the civilian population so that many healthy and younger persons were excluded. Furthermore there were so many adverse factors (including increased hours of work, introduction of rationing, evacuation, bombing, etc.) that it is extremely difficult to separate any single one. The intensification of rationing in 1944 did not cause any change in mortality from the diseases under discussion, but duodenal ulcer deaths showed an increase in 1945, and it has been suggested that this was due to the stress associated with the increased bombing of the previous year. This suggestion, however, is not supported by the work of Illingworth and others (1944), who showed that the rise in perforations of peptic ulcer in 1940 was present in the West of Scotland as well as in London, though the former area was not subject to air raids at that time.

To sum up the secular trends, the mortality due to thyrotoxicosis, gastric ulcer, and rheumatoid arthritis has fallen, that due to asthma and hypertension has remained more or less level, and that due to coronary disease and duodenal ulcer has increased.

Age Incidence

Table I shows the number of deaths per million persons living for each sex, for each decade of life from the age of 25 years, and for the years 1931, 1941, 1944, 1947, and 1950. These years have been chosen because 1931 was the year of the last census for which full information has been published, and from 1941 every third year was included up to 1950, the last year for which full figures are available. Table I also shows the relative importance of the deaths attributed to coronary disease, cardiovascular degeneration, and cerebral haemorrhage, which together account for many thousands of deaths, the less striking numbers due to peptic ulcer and suicide, and the very small numbers due to asthma, thyrotoxicosis, and rheumatoid arthritis. These figures however bear little relation to the morbidity from these diseases.

Mortality increases with increasing age, with the exception of thyrotoxicosis and suicide in females. Although it is frequently reported that the psychosomatic diseases affect mainly middle-aged business and professional men, there was no evidence in 1950 that this referred to the mortality in relation to age. Two hypotheses could account for the increase in mortality with increase in age: First, that it is necessary for the causative factors to operate for a long period of time before death results; thus, if one of these factors is mental stress, then it would be necessary to look back many years to ascertain the exact and particular factor. Second, if the causative factor is of short duration then it must affect the older section of the population more than the younger. As the mortality from these diseases, with the exception of thyrotoxicosis, is associated with concomitant degenerative pathological changes, it could be argued that the mental stress acts as a precipitating or aggravating factor superimposed on degenerative changes such as arteriosclerosis. Whether a life of stress would itself cause arteriosclerosis is another problem. However, there is a further point which is not so speculative. As these diseases are associated with old age, as the age of the population is increasing, as more and more diseases are becoming curable, and as everyone must die eventually, the incidence of diseases associated in any way with degenerative lesions will inevitably increase. Although allowance can be and is made for the ageing population, for example by using the Registrar-General's Comparative Mortality Index*, no allowance can be made for the decrease of deaths due to illnesses now curable.

Sex Incidence

The differences in incidence between the sexes are also shown in Table I. Asthma causes death slightly more frequently in males than in females. This is probably due to occupational causes of asthma in males. Thyrotoxicosis mortality is greater in females as is also the case with rheumatoid arthritis. Gastric ulcer and hypertension show a modest excess of male deaths, but deaths due to cerebral haemorrhage are almost equal.

In deaths from coronary disease, duodenal ulcer, and suicide the male figures are considerably higher in all age groups. It will be noted that these comparisons between the sexes apply to each decade of life for each year since 1931.

Social Class Incidence

Table II shows the standard mortality ratio for each social class for the age group 25 to 64 years for the years 1930–2. These are the deaths related to the number of people reported in each social class as a result of the census of 1931. Once more, striking differences are seen between the diseases. Thyrotoxicosis is far commoner in Class V than in Class I, as also, although to a lesser extent, are cardiovascular degeneration, gastric ulcer, arthritis, and asthma. Coronary disease, duodenal ulcer, and suicide are distinctly commoner in Classes I and II, and cerebral haemorrhage differs in sex incidence, being commoner in Classes I and II in

* This expresses each cause of mortality for each year as a ratio of that for 1938 adopted as the base after adjustment for age differences in the population exposed.

TABLE I

DEATH RATES PER MILLION LIVING, BY SEX AND AGE

Cause of Death	Year	Male						Female					
		25–	35–	45–	55–	65–	75–	25–	35–	45–	55–	65–	75–
Asthma	1931	11	42	96	149	320	468	12	24	48	113	238	320
	1941	13	34	94	144	190	251	14	27	50	84	125	164
	1950	12	26	89	243	353	361	19	32	74	138	221	289
Thyrotoxicosis	1931	4	7	13	18	12	11	30	60	104	128	103	53
	1941	4	6	15	22	15	17	14	31	69	99	112	64
	1944	1	4	9	14	12	4	9	17	47	65	88	49
	1947	1	2	7	10	13	7	6	13	40	71	110	68
	1950	—	3	2	13	11	5	3	7	25	63	83	76
Cerebral Haemorrhage	1931–35	14	79	402	1,590	5,310	11,937	15	78	465	1,511	4,633	10,815
	1941	25	79	375	1,461	4,212	9,783	20	80	498	1,466	4,065	8,909
	1944	34	107	408	1,439	4,110	8,639	20	89	471	1,466	4,032	8,456
	1947	20	78	383	1,374	4,067	9,474	22	96	449	1,418	4,100	9,494
	1950	12	55	293	1,168	3,676	8,410	12	62	399	1,221	3,600	8,766
Coronary Disease	1931	8	55	252	745	1,593	2,005	3	10	45	220	628	1,022
	1941	11	127	621	1,781	3,526	5,095	7	23	118	531	1,599	2,781
	1944	20	161	790	2,195	4,469	5,847	5	26	145	627	1,911	3,222
	1947	22	216	1,054	2,940	6,050	8,647	6	34	180	804	2,628	4,779
	1950	32	268	1,368	4,257	9,028	14,240	6	38	243	1,253	4,353	8,569
Cardiovascular Degeneration	1931	0	9	79	520	2,544	7,855	1	4	52	323	1,516	5,864
	1941	3	19	118	805	3,494	12,019	2	9	80	457	2,373	9,028
	1944	4	10	87	747	3,350	11,482	1	8	62	388	2,257	9,293
	1947	2	13	126	804	3,865	14,848	0	9	73	457	2,742	11,911
Arteriosclerotic Kidney	1941	24	49	145	402	1,002	2,437	18	41	116	294	697	1,585
	1944	44	48	132	309	760	2,032	19	42	99	222	585	1,365
	1947	18	40	123	332	803	2,416	14	43	104	231	563	1,590
Hypertension	1950	12	49	226	822	2,470	5,701	10	33	167	575	1,861	4,903
Gastric Ulcer	1931–33	47	124	256	297	317	297	10	31	77	115	154	188
	1940–42	41	117	248	433	432	431	8	20	47	100	165	238
	1943–45	40	98	213	382	408	377	7	13	35	77	138	195
	1947	14	64	169	297	416	500	3	11	35	77	146	283
	1950	9	40	107	281	456	592	3	9	22	65	148	310
Duodenal Ulcer	1931–33	33	73	136	161	179	187	5	7	16	24	34	54
	1940–42	33	80	149	243	255	250	3	7	15	26	43	54
	1943–45	40	86	147	222	253	248	3	8	16	26	41	58
	1947	22	63	138	228	263	295	2	5	10	18	51	75
	1950	17	49	134	233	370	413	2	6	14	33	60	111
Rheumatoid Arthritis	1939	2	—	13	37	98	202	5	—	27	86	240	489
	1941	2	—	11	40	105	272	6	—	25	75	242	504
	1944	2	—	12	35	82	194	4	—	23	68	193	397
	1947	1	—	6	34	65	185	3	—	21	52	173	371
	1950	1	3	2	18	34	105	—	4	11	29	97	271
Suicide	1931–35	141	209	379	542	534	483	77	108	153	165	135	84
	1941	100	130	180	295	374	414	55	70	113	140	117	67
	1944	108	126	190	269	332	395	48	74	97	118	114	70
	1947	85	114	207	314	383	480	51	80	134	160	166	114
	1950	70	122	222	323	416	421	35	75	124	157	153	115

TABLE II

STANDARD MORTALITY RATIO BY SOCIAL CLASS IN AGE GROUP 25–65 1930–32

Disease	Asthma		Thyrotoxicosis	Cerebral Haemorrhage		Coronary Disease		Cardiovascular Degeneration		Gastric Ulcer	Duodenal Ulcer	Arthritis		Suicide	
Sex	M	F	F	M	F	M	F	M	F	M	M	M	F	M	F
Social Class I	89	88	59	112	75	237	157	77	54	55	101	90	91	128	128
Social Class II				106	90	148	126	92	75	76	106			151	135
Social Class III	102	106	93	101	101	95	93	94	99	99	99	98	102	94	95
Social Class IV	105	98	89	96	108	66	84	105	110	109	93	115	106	95	85
Social Class V	106	103	196	96	110	67	89	122	129	127	107	103	103	90	87

males and in Classes IV and V in females. Recent studies have shown that the present social class incidence, although similar to that of 1931, has shown some levelling off (Logan, 1952; Doll and Avery-Jones, 1951).

Geographical Incidence

Table III shows the differences between England and Wales generally (taken as 100) as compared with Greater London, the County Boroughs, the Urban Districts, and the Rural Districts. Some idea may thus be obtained of the effect of urbanization upon the death rates. Cardiovascular degeneration, coronary disease, duodenal ulcer in males, gastric ulcer in males and females (except in London), and suicide in females show a decrease in mortality with a decrease in urbanization; thyrotoxicosis shows the reverse trend, and cerebral haemorrhage although lower in London is more or less equal in the rest of the country.

Seasonal Incidence

The Registrar-General's Annual Statistical Review for 1949 (Medical Table No. 23, not reproduced here) shows the number of deaths occurring from each cause by months. The incidence of asthma, cerebral haemorrhage, myocardial degeneration, coronary disease, and peptic ulcer is lowest from June to October. The incidence of suicide is highest at that season, and thyrotoxicosis and rheumatoid arthritis show little seasonal variation.

Occupational Incidence

A study of the occupations associated with the highest death rates from these diseases reveals trends similar to those already described in connection with social class and geographical incidence. Thyrotoxicosis is found most commonly in the wives of farmers, gardeners, nurserymen, retail proprietors, carpenters, and agricultural labourers—a marked preponderance of rural occupations. Coronary disease is most marked in doctors, wholesale proprietors, lawyers, and clergymen, all members of Class I. Hypertension and cerebral haemorrhage are more common in hotel-keepers, barmen, textile dyers, furnacemen, rollers, and grinders. Duodenal ulcers, gastric ulcers, rheumatoid arthritis, and asthma occur in diverse occupational groups including coal-miners (particularly asthma and "arthritis"), typists, clerks, managers, and general labourers. In 1931 rheumatoid arthritis was not shown separately from other forms of arthritis, and there is little doubt that, among the coal-miners particularly, asthma and arthritis would include some cases of pneumonoconiosis and traumatic arthritis respectively.

Table IV (opposite) summarizes the foregoing sections; it shows that the three conditions which have decreased in recent years (thyrotoxicosis, gastric ulcers, and rheumatoid arthritis) show a maximum incidence in Social Classes IV and V, and that thyrotoxicosis and rheumatoid arthritis are higher in females. These diseases show little seasonal variation and female cases either show no geographical variation or are more numerous in the rural areas.

By contrast, coronary disease and, to a lesser extent, duodenal ulcer show a definite rise in incidence, a preponderance in males, an excess in Social Classes I and II (coronary disease), an excess in urban areas, and a lower incidence in the spring and summer.

Asthma, cerebral haemorrhage, and myocardial degeneration have remained level, affect males only slightly more than females, tend to occur more frequently in Social Classes IV and V, bear little relation to urbanization, and have a lower incidence in the spring and summer.

TABLE III

GEOGRAPHICAL DISTRIBUTION OF DEATHS, BY SEX

Source of Information		Comparative Mortality Figure, 1940–44				Ratio—Deaths per million living, 1947									
Disease		Cardio-vascular Degeneration		Coronary Disease		Thyrotoxi-cosis		Cerebral Haemorr-hage		Duodenal Ulcer		Gastric Ulcer		Suicide	
Sex		M	F	M	F	M	F	M	F	M	F	M	F	M	F
Area	England and Wales	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	Greater London ..	107	114	127	124	75	63	82	75	107	100	118	83	93	111
	County Boroughs ..	114	110	100	94	100	86	109	108	115	93	111	113	103	106
	Urban Districts ..	95	93	97	98	100	114	107	106	94	100	95	91	99	95
	Rural Districts ..	85	86	82	91	100	132	91	103	80	100	73	105	105	82

TABLE IV

SUMMARY OF TRENDS OF MORTALITY FIGURES, 1931–1950

Disease	Secular Trend	Maximum Age Incidence	Sex Incidence	Social Class	Geographical Peak	Seasonal Peak	Associated Occupation
Asthma	Level	65+	Male	IV–V	—	Winter	Mixed
Thyrotoxicosis	Fall	55–74	Female	V	Rural	Equal	Rural
Cerebral Haemorrhage	Level	65+	Equal	Equal	Equal	Winter	Mixed
Coronary Disease	Rise	65+	Male	I–II	Urban	Winter	Professional
Myocardial Degeneration	Level	65+	Male	IV–V	Urban	Winter	Mixed
Gastric Ulcer	Fall	65+	Male	IV–V	Urban (in males)	Autumn-Spring	Mixed
Duodenal Ulcer	Rise	65+	Male	Equal	Urban	Autumn-Spring	Mixed
Rheumatoid Arthritis	Fall	65+	Female	IV–V	—	Equal	Mixed
Suicide	Fall	65M 55–74F	Male	I–II	Urban (in females)	Spring Summer	Mixed

DISCUSSION

It is frequently suggested that the increasing complexities of town life have caused the present increase in the diseases of stress and strain. However the large towns have a larger proportion of the population in Class V than the rural areas, and one would expect the effects of urbanization to be associated with a higher incidence in Class V. Further, the monotony of town and factory life, the artificiality of the cinema, etc., fall more heavily on the people of Classes IV and V. The suggestion that the frustration of business life is to blame could not account for the markedly high incidence in the professions and the lower incidence in managers and other business men.

In search of some explanation of these enigmata, many protagonists of psychosomatic medicine have tried to relate personality with disease incidence and have accounted in this way for some of the epidemiological features.

Thus Dunbar (1943), examining a series of in-patients, found that:

> Patients with coronary disease have very unusual educational records, showing a marked tendency to complete the academic unit undertaken, and a generally high educational average.

The income of such patients was high, and they manifested an especially clear-cut constellation of personality traits and a typical life pattern of asceticism and hard work enforced by compulsions. Such a description could certainly fit the successful professional man, and those possessing such personalities would tend to rise to Social Classes I and II and to make a career in one of the professions.

Davies and Wilson (1937), Gilsenan (1946), Ryle (1948), and Doll and Avery-Jones (1949; 1951) describe the duodenal ulcer type as cautious, reliable, conscientious, often over-serious, and ambitious. Ryle added a characteristic touch to his description in the following words:

> If engaged in business their city lunch is an occasion not for respite and digestion, but for more business.

Such characteristics would be more associated with Classes I and II and such persons would tend to move from the country to the city.

In complete contrast are the personality patterns described in connection with thyrotoxicosis, asthma, and rheumatoid arthritis. Halliday (1942) found marked emotional self-restriction and obsessional trends in his cases of rheumatoid arthritis, Rogerson and others (1935) found an association between asthma in children and over-protectiveness, Rubin and Moses (1944) considered asthmatic sufferers to be fundamentally of a passive dependent type, and Abramson (1951) described them as submissive and obedient. Moschowitz (1930), Conrad (1934), and Lidy and Whitehon (1950) found thyrotoxic patients striving to gain affection and protection from others:

> Inordinately insecure, they concentrate their efforts on gaining the affection of a parent, a child, or sometimes a spouse, by self-sacrifice.

Rennie (1939) found a life-long instability, over-attention to bodily symptoms, and a smouldering resentment in a selected group of patients with hypertension. Dunbar (1943) found that patients with hypertension had a relatively low educational level and described them as ambitious but assailed

by doubt, wishing to be in authority and at the same time wishing to be taken care of. These descriptions are compatible with the epidemiological findings, in as much as hypertension occupies an intermediate position between the coronary-duodenal group (ambitious-successful) and the thyrotoxic-arthritic group (dependent-doubting).

The studies of Selye in relation to stress and the general adaptation syndrome (Selye, 1950) also lend support to the broad epidemiological categories of the psychosomatic diseases. Thus coronary artery disease (with increased liability to clotting) and acute gastro-intestinal erosions are manifestations of increased secretions of ACTH and of glucocorticoids, and both conditions are aggravated by cortisone. Carlisle (1950) has also shown that duodenal ulcers and coronary disease are contraindications to the use of cortisone. Asthma, rheumatoid arthritis, and gout (another disease that has decreased in recent years) are manifestations of later stages in the reaction to stress and are quickly reversible by treatment with cortisone. Hypertension is a manifestation of increased somatotrophic hormone and mineralocorticoids and its reaction to cortisone is equivocal, as is also that of thyrotoxicosis.

Conclusion

It is admitted that every illness arises from a constellation of many factors, or to quote Lord Samuel's "Essay in Physics" (1951):

> No event can emanate from another single event; no effect is ever the product of one cause, but always of a combination of causes.

Nevertheless the isolation of even minor factors may help towards the elucidation of the whole complex. It is suggested that the present study shows two extreme and opposite types of psychosomatic disease: one associated with the active, ambitious personality, with the "alarm reaction" of Selye, and aggravated by cortisone (examples being coronary disease and duodenal ulcer), and the other associated with the passive, dependent personality, at a later stage of adaptation than the alarm reaction, and able to be relieved by cortisone.

For the first type the mortality rate is increasing, is commoner in males, and in Social Classes I and II, and is seen more commonly in urban areas. For the second type the mortality rate has decreased or remained level, is commoner in females or equal between the sexes, occurs more often in Social Classes IV and V, and shows little difference in distribution between urban and rural areas. These points of contrast seem to suggest that contemporary psychological factors play a greater part in the first type, whilst deeper and more distant psychological factors are dominant in the second group. In both types, of course, psychological factors may cause an exacerbation of an existing illness.

Summary

(1) A study of the mortality figures for certain psychosomatic diseases shows that there has been an increase in coronary artery disease and duodenal ulcer, and a decrease or levelling off in thyrotoxicosis, asthma, rheumatoid arthritis, and gastric ulcer.

(2) The diseases which have increased are commoner in males and in urban areas.

(3) The diseases which have increased are reported to be associated with ambitious personalities, whilst those which have decreased are associated with dependent personalities.

(4) The diseases which have increased are aggravated by the administration of cortisone, whilst the others are relieved.

(5) The mortality figures provide no evidence to justify the frequent generalization that all the psychosomatic diseases are rapidly increasing because of the complexities of modern civilization. There does however seem to be some evidence that certain groups or types of people are failing to adapt themselves to certain environmental stresses. No evidence regarding the nature of these stresses is adduced.

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GEOGRAPHICAL AND SOCIAL VARIATIONS IN THE INCIDENCE OF NOTIFIED POLIOMYELITIS

BY

B. BENJAMIN and W. P. D. LOGAN

From the General Register Office, London

The natural history of poliomyelitis is not yet completely written. Although the clinical features of this disease have been recognized for more than a century, problems of management still give rise to controversy, and in spite of recurring outbreaks of widespread and dramatic character many enigmatic features of epidemiology remain to be explained. The outbreaks come without presage, reaching dimensions which cannot be forecast, and burning themselves out almost completely uncontrolled. While in the laboratory the search for prophylactic measures continues, there remains in the field a need for that combination of observation and hypothesis which may add to the accumulated epidemiological knowledge and consequently may add if even slightly to the state of preparedness of local health services. To this pattern, and in succession to an earlier review (Logan, 1952), the present study belongs.

If it were found that poliomyelitis reached epidemic prevalence invariably after a particular series of movements of attack rates or that the disease selected particular sections of the community or parts of the country, this would enable us to predict the commencement and spread of outbreaks, thus enabling clinical services to be mobilized on an adequate scale.

Uneven Prevalence in Different Areas

It is known that in individual outbreaks, even in urban areas, some localities may escape epidemic prevalence, for reasons which are not apparent, and also that areas which suffer high incidence in one epidemic may have a lower than average incidence in the next, perhaps by some carry-over of the herd immunity gained in the earlier outbreak (Breen and Benjamin, 1950). These two effects, independent geographical variation and correlation between one local outbreak and the next, operate together; jointly they produce in any one outbreak considerable unevenness in geographical spread. In order to remove this second effect, carry-over of a higher level of immunity from the close of one epidemic to the onset of the next, it is necessary to average the prevalence over several epidemics. The question then remains whether the residual geographical variation in epidemicity is a matter of chance and a feature which will also disappear over a further period as individual localities experience their proportionate share of the total prevalence in due course.

Table I (overleaf) shows the result of averaging the years 1947–50: three years of severe epidemic prevalence and one year (1948) with comparatively few cases. In this Table the actual uncorrected* notifications are compared with those "expected" if the England and Wales total notifications were distributed in proportion to the local population, *i.e.* if every area suffered the same attack rate. Looking first at each region as a whole, we find that prevalence was significantly† *below* average in the Northern, North Western, and Eastern Regions, and in Wales, and that it was significantly *above* average in the Midland, London and South Eastern, Southern, and South Western Regions.

In the remaining regions the differences between actual and expected notifications were not statistically significant. The significant differences are too large to be accounted for by the fact that (to be consistent with Table V) uncorrected notifications

*Uncorrected notifications are the *original* notifications made to local Medical Officers of Health and transmitted to the General Register Office weekly; corrected notifications are the *final* notifications returned by the Medical Officer of Health quarterly, after taking account of corrections of diagnoses during the period.

†The criterion has been twice the standard error of the "expected".

TABLE I

COMPARISON OF ACTUAL AND EXPECTED* ORIGINAL NOTIFICATIONS OF POLIOMYELITIS IN COUNTY BOROUGHS AND ADMINISTRATIVE COUNTIES, 1947–50

Region	County Borough	Actual	Expected	Sig.	Actual % Expected	Administrative County	Actual	Expected	Sig.	Actual % Expected
Northern	Carlisle	26	42	−	62	Cumberland	146	134		109
	Darlington	14	54	−	26	Durham	525	568		92
	Gateshead	50	73	−	68	Northumberland	258	276		93
	Middlesbrough	59	92	−	64	Westmorland	51	43		119
	Newcastle-on-Tyne	235	187	+	126	Yorkshire (North Riding)	201	224		90
	South Shields	60	68		88					
	Sunderland	108	115		94					
	Tynemouth	31	42		74					
	West Hartlepool	22	46	−	48					
	Total—County Boroughs and Administrative Counties						1,786	1,964	−	91
East and West Ridings of Yorkshire	Barnsley	83	48	+	173	Yorkshire (East Riding)	117	133		88
	Bradford	177	184		96	Yorkshire (West Riding)	1,054	1,000		105
	Dewsbury	39	33		118					
	Doncaster	40	51		78					
	Halifax	20	61	−	33					
	Huddersfield	67	81		83					
	Kingston-on-Hull	152	189	−	80					
	Leeds	330	320		103					
	Rotherham	37	52	−	71					
	Sheffield	342	325		105					
	Wakefield	35	37		95					
	York	121	66	+	183					
	Total—County Boroughs and Administrative Counties						2,614	2,580		101
North Western	Barrow-in-Furness	38	43		88	Cheshire	414	508	−	81
	Birkenhead	62	89	−	70	Lancashire	956	1,278	−	75
	Blackburn	20	71	−	28					
	Blackpool	37	95	−	39					
	Bolton	64	107	−	60					
	Bootle	26	44	−	59					
	Burnley	12	54	−	22					
	Bury	18	37	−	49					
	Chester	25	30		83					
	Liverpool	442	505	−	88					
	Manchester	506	443	+	114					
	Oldham	33	77	−	43					
	Preston	32	75	−	43					
	Rochdale	35	56	−	63					
	St. Helens	26	70	−	37					
	Salford	181	114	+	159					
	Southport	15	54	−	28					
	Stockport	44	90	−	49					
	Wallasey	31	64	−	48					
	Warrington	36	50		72					
	Wigan	33	54	−	61					
	Total—County Boroughs and Administrative Counties						3,086	4,008	−	77
North Midland	Derby	57	90	−	63	Derby	249	429	−	58
	Grimsby	92	58	+	159	Leicester	192	217		88
	Leicester	295	179	+	165	Lincoln—Holland	99	64	+	155
	Lincoln	44	44		100	Lincoln—Kesteven	168	77	+	218
	Northampton	58	66		88	Lincoln—Lindsey	237	190	+	125
	Nottingham	141	190	−	74	Northampton	186	159	+	117
						Nottingham	269	330	−	82
						Peterborough	37	40		93
						Rutland	18	13		138
	Total—County Boroughs and Administrative Counties						2,142	2,146		100

*On the basis of the England and Wales notification rate applied to the local population.

TABLE I (*continued*)

Region	County Borough	Actual	Expected	Sig.	Actual % Expected	Administrative County	Actual	Expected	Sig.	Actual % Expected
Midland	Birmingham	1,060	702	+	151	Hereford	117	79	+	148
	Burton-on-Trent	19	31	−	61	Salop	126	172	−	73
	Coventry	148	160		93	Stafford	496	530		94
	Dudley	81	40	+	203	Warwick	369	303	+	122
	Smethwick	50	49		102	Worcester	272	248		110
	Stoke-on-Trent	87	175	−	50					
	Walsall	60	72		83					
	West Bromwich	24	55	−	44					
	Wolverhampton	107	102		105					
	Worcester	43	39		110					
	Total—County Boroughs and Administrative Counties						3,059	2,757	+	111
Eastern	Great Yarmouth	31	33		94	Bedford	242	191	+	127
	Ipswich	18	66	−	27	Cambridge	54	104	−	52
	Norwich	96	75	+	128	Ely	21	57	−	37
	Southend-on-Sea	76	94		81	Hertford	381	377		101
						Huntingdon	33	41		80
						Norfolk	258	223	+	116
						Suffolk (East)	108	135	−	80
						Suffolk (West)	52	71	−	73
	Total—County Boroughs and Administrative Counties						1,370	1,467	−	93
London and South Eastern	Brighton	93	99		94	Essex	973	983		99
	Canterbury	13	16		81	Kent	1,061	945	+	112
	Croydon	146	158		92	London	2,743	2,147	+	128
	Eastbourne	13	36	−	36	Middlesex	1,433	1,445		99
	East Ham	44	77	−	57	Surrey	861	847		102
	Hastings	37	42		88	Sussex (East)	199	213		93
	West Ham	56	110	−	51	Sussex (West)	175	197		89
	Total—County Boroughs and Administrative Counties						7,847	7,315	+	107
Southern	Bournemouth	86	88		98	Berkshire	191	176		109
	Oxford	60	67		90	Buckingham	203	238	−	85
	Portsmouth	92	139	−	66	Dorset	300	174	+	172
	Reading	64	73		88	Oxford	87	103		84
	Southampton	139	114	+	122	Southampton	382	366		104
						Isle of Wight	141	59	+	239
	Total—County Boroughs and Administrative Counties						1,745	1,597	+	109
South Western	Bath	58	49		118	Cornwall	279	211	+	132
	Bristol	636	279	+	228	Devon	376	317	+	119
	Exeter	52	48		108	Gloucester	284	267		106
	Gloucester	24	41	−	59	Somerset	344	295	+	117
	Plymouth	71	120	−	59	Wiltshire	269	222	+	121
	Total—County Boroughs and Administrative Counties						2,393	1,849	+	129
Wales	Cardiff	158	154		103	Anglesey	8	31	−	26
	Merthyr Tydfil	22	38	−	58	Brecknock	27	34		79
	Newport	26	67	−	39	Caernarvon	49	78	−	63
	Swansea	114	101		113	Cardigan	15	34	−	44
						Carmarthen	114	108		106
						Denbigh	93	107		87
						Flint	88	88		100
						Glamorgan	347	462	−	75
						Merioneth	19	25		76
						Monmouth	98	202	−	49
						Montgomery	43	29	+	148
						Pembroke	26	55	−	47
						Radnor	20	13	+	154
	Total—County Boroughs and Administrative Counties						1,267	1,626	−	78
England and Wales	TOTAL—County Boroughs	8,355	8,624		97	TOTAL—Administrative Counties	18,954	18,685		101
	TOTAL—all County Boroughs and Administrative Counties combined						27,309	27,309		100

have been used. The ratios of corrected (final) to uncorrected (original) notifications in each region are shown in Table II.

TABLE II

ACUTE POLIOMYELITIS
Corrected Notifications per 100 Original Notifications at All Ages. Standard Regions, 1947–50 (average)

Region*	Corrected Notifications per 100 Original
Northern	87
East and West Ridings of Yorkshire	87
North Western	77
North Midland	89
Midland	86
Eastern	89
London and South Eastern	83
Southern	94
South Western	87
Wales	87
Total (England and Wales)	85

*As defined in publications of the Registrar-General

Looking now at individual towns and counties, the following contrasts may be noted:

Significance Excesses	Significant Deficiencies
Newcastle, Barnsley, York, Manchester, Salford	Most other towns and outlying areas of north of England.
Grimsby, Leicester, and most of Northamptonshire and Lincolnshire	Derby, Nottingham, and surrounding county areas.
Birmingham, Dudley, and parts of Warwickshire and Herefordshire	Burton-on-Trent, Stoke-on-Trent West Bromwich, and county of Shropshire
Norwich, and counties of Bedford and Norfolk	Ipswich and county districts of Suffolk, Cambridge, and Ely.
London and the county of Kent. (Prevalence in the other Home Counties — Surrey, Middlesex, Essex—was close to expectation)	East Ham, West Ham, Eastbourne.
Southampton, Bristol, and county districts of Dorset, Isle of Wight, Cornwall, Devon, Somerset, and Wiltshire	Gloucester, Portsmouth, Plymouth, Buckinghamshire.
Montgomery and Radnor	Rest of Wales.

No obvious explanation suggests itself why the two similar towns of Ipswich and Norwich or the similar counties of Suffolk and Norfolk should experience widely different levels of prevalence, or why differences should exist between Portsmouth and Southampton, between Bristol and Nottingham, between Hereford and Shropshire, between Leicester and Derby, between inner London and the contiguous dense urban areas of West Ham and East Ham, or between Manchester and the almost indistinguishable urban area of Stockport. Even the apparently common factor of high prevalence in the major towns of London, Manchester, Birmingham, Newcastle, Bristol, Leicester, and Southampton, and (to a non-statistically significant extent) in Sheffield and Leeds, is invalidated by the exclusion of Liverpool, Bootle, Kingston-on-Hull, Nottingham, Stoke-on-Trent, and Portsmouth, and many other towns which approach them in size.

SOCIAL CONDITIONS

The question arises whether the differential incidence of poliomyelitis in towns and counties is associated with social factors such as standards of living and hygiene or housing density. No correlation has yet been established between social class and poliomyelitis incidence when indirect indices are used, such as the proportions of local populations engaged in certain occupational groups (Daley and Benjamin, 1948) or infant mortality (Hill and Martin, 1949), but there has been a suggestion that overt (as distinct from subclinical) cases of poliomyelitis tend to appear relatively less frequently in more crowded housing conditions (Daley and Benjamin, 1948).

An examination of the variability of poliomyelitis incidence was made by extracting, for each County Borough and Administrative County, the corrected (final) notification rate at all ages for the years 1947–50 inclusive, the average number of persons per dwelling (this is both a measure of crowding, though not necessarily overcrowding, and a measure of the equally important number at risk in households), and the percentage of the male population over the age of 15 with occupations in Social Classes IV and V (Census 1951, 1 per cent. Sample Tables), *i.e.* persons in unskilled occupations.

The coefficients of correlation between the notification rate and both the housing density index and the proportion in the lower social classes were then calculated. In making these calculations the County Boroughs were zoned (Northern, Midland, Southern, etc.) to permit of the emergence of any differential association for parts of the country. The results coefficients is significantly different from zero. If (Table III, opposite) indicate that poliomyelitis incidence (as measured by notification) is not sensibly associated with the proportion of the population in occupations of low social status. None of the socio-economic environment is measured by the adopted index, *viz.* proportion in Social Classes IV and V, then it appears unlikely that this is a factor influencing the transmission of or the susceptibility to poliomyelitis in different areas.

The findings are equally negative in relation to housing density. None of the correlation coefficients is significantly different from zero. There is thus no evidence that the different notification rates in

TABLE III

CORRELATION BETWEEN POLIOMYELITIS INCIDENCE AND SOCIAL FACTORS IN COUNTY BOROUGHS AND ADMINISTRATIVE COUNTIES OF ENGLAND AND WALES, 1947–50

Areas		Number of Areas	Mean Notification Rate of Poliomyelitis at All Ages per 100,000 (1947–50)	Mean Proportion of Male Population aged 15+, in Social Classes IV and V, per cent. (1951, 1 per cent. Sample Table)	Number of Persons per Dwelling	Correlation Coefficients between Poliomyelitis Notifications and	
						Social Class	Housing Density
County Boroughs in Groups of Standard Regions*	Northern East and West Ridings of Yorkshire North Western	42	10·0	32·2	3·21	+0·176	+0·139
	North Midland Midland Eastern	20	15·9	28·1	3·27	−0·105	−0·054
	Greater London South Eastern Southern South Western Wales	21	12·6	26·6	3·15	−0·167	−0·124
All County Boroughs		83	12·7	29·6	3·21	−0·118	+0·061
All Administrative Counties		62	13·9	28·7	3·18	−0·146	−0·033
All Areas		145	13·5	29·0	3·19	−0·114	+0·040

*Standard Regions as defined in publications of the Registrar-General.

different areas of the country are associated with different levels of housing density as measured by the adopted index of persons per dwelling.

Urbanization as such, apart from housing density, does not seem to be a factor. In a general review of the years 1947–50 Martin (1951) found no evidence that the towns had a greater liability than the rural districts.

DIFFERENTIAL EXPOSURE

One might approach the problem by considering the exposure of individual families. More often than not poliomyelitis spreads rapidly and diffusely (Daley and Benjamin, 1948), defying attempts to identify foci or to trace spread from infector to infected, except in some of the more localized outbreaks (as for example in the Isle of Wight in 1950—Ministry of Health, 1952). Nevertheless a virus which moves so disconcertingly quickly must still require the assistance of a vector, human or otherwise, and must emanate from some source of supply. If differential attack rates in families could be established in conditions comparable in all aspects except degree and type of contact with specific sections of the community, then an examination of the variability of such contact might be profitable.

The daily contact risk of an individual is inseparable from, but largely determined by, the manner in which he earns his living, though we have shown that it is not correlated with socio-economic status as measured by occupation. In 1949, classifying cases of poliomyelitis by occupation of father, the Medical Officer of Health for Essex (Cowan, 1950) found that the occupations of bus conductor and bus driver were associated with an unexpectedly high number of cases (in the families, not in the fathers); but small numbers were involved and there have been no further reports confirming this suggestion. Logan (1953) has drawn attention to the frequent mention of school teachers as parents of cases of poliomyelitis in Southend C.B. in 1952.

OCCUPATION.—In order to make a test of these two last suggestions in particular and occupational association (in families) in general, the notified cases of (confirmed) poliomyelitis in children under the age of 15 in the County of London in 1949 and 1950 were collected, and the help of the Health Visitors was enlisted to trace and classify them by occupation of the principal wage earner of each family. The results are shown in Table IV (overleaf).

It was practicable by reference to a random sample of London families, all with at least one child (Hartston and Gore, 1953), to make an allocation, by occupation of principal wage earner of household, of a sample of *all* children under 15 (whether cases of poliomyelitis or not) and thus to provide the relevant numbers at risk, but no direct calculations of attack rates were made in view of the small numbers involved. A comparison was, however, made between actual distribution (Column 5) with that expected on the basis of the occupational distribution of the children (Column 6).

TABLE IV

POLIOMYELITIS CASES AT AGES 0–14 IN LONDON A.C. 1949–50 BY OCCUPATION OF PRINCIPAL WAGE EARNER

1950 Code of Occupation (1)	Occupational Group (2)	Number of Children aged 0–14 with Principal Wage Earner in Group, London Sample (Hartston and Gore) (3)	Cases of Poliomyelitis in Children, by Occupation Group of Principal Wage Earner of Family			
			Actual Number of Cases (4)	Adjusted to Include Rateable Distribution of "Not ascertained" (5)	Expected on Basis of Col. (3) (6)	(5)−(6) (7)
010–030	Agriculture, forestry	6	2	2	2	—
070–079	Glass, glassware	22	1	1	8	− 7
090–109	Coal, gas, coke, chemicals	28	—	—	10	−10
110–279	Metal, engineering, allied trades	340	109	127	125	+ 2
350–379	Leather, boot, shoe, fur	14	7	8	5	+ 3
380–419	Textile goods, articles of dress	41	25	29	15	+14
420–469	Food, drink, tobacco (makers)	27	13	15	10	+ 5
470–489	Wood, cane, cork	100	24	28	37	− 9
500–539	Paper, bookbinding, printing	36	8	9	13	− 4
540–579	Miscellaneous products (rubber, plastics, surgical appliances, musical instruments, etc.)	27	5	6	10	− 4
580–599	Building, contracting	135	41	48	50	− 2
600–609	Painting, decorating	86	24	28	32	− 4
610–629	Administration, directing, managing	29	3	3	11	− 8
630–649	Railway transport	40	12	14	15	− 1
650–669	Road transport	256	79	92	94	− 2
670–689	Water transport	25	14	16	9	+ 7
690–709	Other transport (including Post Office)	73	17	20	27	− 7
710–749	Commercial (wholesale and retail businesses, brokers, advertisers, etc.)	140	64	74	51	+23
750–759	Finance, insurance	19	9	10	7	+ 3
760–819	Professional	84	39	45	31	+14
820–839	Defence	95	25	29	35	− 6
840–855	Entertainment, sport	19	3	3	7	− 4
861–888	Personal service (domestic service, clubs, hotels, etc.)	108	41	48	40	+ 8
890–895	Clerks, typists	169	34	40	62	−22
900–909	Warehousemen, packers	58	23	27	21	+ 6
910–921	Stationary engine drivers	29	6	6	11	− 5
930–950	Unskilled occupations	185	59	69	68	+ 1
	Undefined or not specified above	53	16	19	20	− 1
	Not gainfully occupied	5	10	12	2	+10
	Not ascertained	—	115	—	—	—
Total		2,249	828	828	828	—

The number of cases of poliomyelitis for whom no occupation of principal wage earner could be stated (mostly "removals" in the intervening period), have been distributed over the occupations in proportion to the "stated" cases. Column 4 includes 26 cases of poliomyelitis where there was no father living, which were classed by occupation of mother, and an unknown but probably small number where the child was not living with the father (*e.g.* a residential nursery case).

When the actual distribution is compared with that expected from the estimated occupational distribution of all children, there are no differences large enough to be accepted as statistically significant, having regard to sampling errors in both Columns 5 and 6, but there are large excesses over expectation in the families of workers in textile goods and articles of dress (193 per cent. of expected), and in commercial occupations (mainly wholesale or retail businesses) (145 per cent. of expected). There are rather large deficiencies from expectation in the families of clerks (65 per cent.) and administrators and directors (27 per cent.).

There are, however, several factors to be taken into account which lead us to reject these differences as being associated with occupational contact. In the first place, the differences, though large, are within the range of sampling fluctuation. Secondly, the particulars of occupation of principal wage earner as given to the Health Visitor are not always detailed and errors in assignment may have been made. The coding was done carefully and errors were minimized, but this source of possible error must not be overlooked. It is possible that the excess in commercial workers' families and the deficiency in those of clerks and typists represent compensating errors of this kind.

Thirdly, it is important to remember that we are dealing with one member of a family only, *viz.* the father (and, in a very small number of cases, the mother). There is no reason to suppose either that he is the only person likely to bring virus to his children, or that the other members of the family who may serve as vectors, *e.g.* elder sisters, have a similar occupational distribution. Thus, the high incidence in children of fathers in a certain occupation

may be due to excessive contacts by other children of same family or to the employment of other members of the family in quite different occupations.

EXPOSURE RISK.—There is in addition another important factor which has been the cause of many epidemiological fallacies in the past (Greenwood, 1935), namely, that the children in families of different occupational groups of fathers may also vary in their exposure and immunity experience not only by virtue of the factors already mentioned above but also as a result of different educational or recreational facilities or different locality of residence.

NEED FOR FURTHER STUDY.—On the whole, the differences in Column 6 of Table IV are very small, and the one or two larger differences may be discounted as sampling fluctuations or coding errors unless confirmed. It seems unlikely that there are real differences in the risk of contracting poliomyelitis which can be associated with the occupation of the principal wage earner of the family. This is perhaps not surprising with so ubiquitous a virus, but supposition is not enough and further study would be justified by the necessity for a clear verdict. Meanwhile, there would seem to be no real justification for premature anxiety or complacence on the part of any occupation.

So far as bus and tram conductors are concerned, the numbers of poliomyelitis cases assigned to their families numbered nine against an expectation (from greater detail than given in Table IV) of ten. School teachers had eight cases in their families against an expectation of five; the excess is not statistically significant and is not proportionately greater than that of the whole professional group in Table IV.

TIMING OF HIGH PREVALENCE

It is possible that the period 1947–50, only the first four years since the emergence of epidemic conditions in England–Wales (on more than a very local scale) is not long enough for a stable pattern of geographical variation in prevalence to have developed. If this is so, then areas which have hitherto suffered under-average prevalence can have no guarantee that this favourable experience will continue.* It is a possibility to be reckoned with that areas which in Table I are shown as significant "minus" may have to deal with larger numbers of cases in the future. This is especially to be borne in mind in view of the fact that only a small part of the variation between areas in 1947–50 has been explained by social factors—this itself is a hint that the pattern is still not permanent, and that spread from area to area, is still disturbed and irregular simply from the play of chance and circumstance. It is, however, also probable that we have not been measuring the variation in the prevalence of *infection* since we have left out of account the presumptively large number of subclinical cases which are not detected and are therefore not notified; the ratio of subclinical to overt cases in urban areas may well vary between wide limits with variation in local standards of hygiene.

Aside from all these reservations, we may consider notifications in any one area as a local index of prevalence, geared to the true prevalence of infection in manner perhaps peculiar to the locality, but nevertheless stable. If this is so, we may look at the rhythm of epidemic ebb and flow of cases in individual areas, in order, as we suggested in the introduction, to discern whether or not there is anything in the contour of the epidemic waves which would make it possible to forecast the subsequent attainment of major prevalence. It had been noticed in 1950 that in both Bristol and Birmingham outbreaks of notified poliomyelitis of greater proportions than the average for the country as a whole were preceded by an unusually high incidence in those areas in the winter (the first quarter of the year). In Bristol this occurred also in 1949 and in Birmingham also in 1947.

In order to test the generality of this conjunction of events, the original notifications in the county boroughs and administrative counties of England and Wales have been tabulated by quarters for the period 1947–50, and in each quarter have been compared with "expected" numbers on the basis of the notification rates for England and Wales as a whole (as in Table I). Shortage of space prohibits publication of the full tabulation but a selection is shown in Table V (overleaf) to indicate the method. A plus sign (significant excess over expectation) in the first quarter followed by a plus sign in the third quarter (regardless of the second or fourth quarters, which are nevertheless highly correlated with the third quarter) occurs six times among county Boroughs. There are 83 such towns with four years of experience each; a plus in the first quarter occurred nineteen times and a plus in the third quarter 45 times. On the assumption that winter and summer prevalences are independent, we should expect the occasions on which the two plus signs *coincide* to amount to:

$$332\left(\frac{19}{332}\times\frac{45}{332}\right)=2\cdot6\pm1\cdot6.$$

*Preliminary results for 1952 show that of 38 county boroughs in this category only three (Gateshead, West Hartlepool, and Burton-on-Trent) had above-average prevalence.

TABLE V

NUMBER OF ORIGINAL NOTIFICATIONS, EXPECTED NUMBER, PLUS OR MINUS FOR SIGNIFICANT DIFFERENCES, AND ACTUAL NUMBER PER CENT. OF EXPECTED, 1947–50

A selection of County Boroughs and Administrative Counties*

Year		BARNSLEY				BIRMINGHAM				HERTFORDSHIRE			
		Actual	Expected	Sig.	Actual % of Expected	Actual	Expected	Sig.	Actual % of Expected	Actual	Expected	Sig.	Actual % of Expected
1947	1	—	0·2		—	10	3·1	+	323	2	1·6		125
	2	2	0·5	+	400	10	7·7		130	5	4·1		122
	3	12	11·4		105	205	167·2	+	123	82	89·8		91
	4	3	4·2		71	78	66·2		118	42	33·4		126
1948	1	—	0·8		—	24	11·4	+	211	6	6·1		98
	2	—	0·5		—	12	6·7	+	179	3	3·6		83
	3	4	1·4	+	286	26	19·9		131	13	10·7		121
	4	8	1·3	+	615	18	19·6		92	14	10·5		133
1949	1	1	0·4		250	9	6·3		143	7	3·4		206
	2	1	0·5		200	4	7·5		53	6	4·0		150
	3	9	5·5		164	50	80·4	−	62	54	43·2		125
	4	23	5·8	+	397	60	84·5	−	71	61	45·4	+	134
1950	1	3	0·9	+	333	28	13·1	+	214	4	7·0		57
	2	4	1·3	+	308	154	18·5	+	832	9	9·9		91
	3	5	9·1		55	287	133·4	+	215	46	71·6	−	64
	4	8	4·1		195	85	60·4	+	141	27	32·4		83

Year		BOOTLE				BRISTOL				LONDON			
		Actual	Expected	Sig.	Actual % of Expected	Actual	Expected	Sig.	Actual % of Expected	Actual	Expected	Sig.	Actual % of Expected
1947	1	—	0·2		—	2	1·2		167	16	9·4	+	170
	2	—	0·5		—	3	3·0		100	30	23·4		128
	3	2	10·5	−	19	61	66·3		92	785	511·2	+	154
	4	3	3·9		77	26	24·7		105	224	190·4	+	118
1948	1	1	0·7		143	6	4·5		133	48	34·7	+	138
	2	—	0·4		—	6	2·7		222	30	20·4	+	147
	3	2	1·3		154	18	7·9	+	228	76	61·0		125
	4	1	1·2		83	16	7·8	+	205	58	60·1		97
1949	1	1	0·4		250	9	2·5	+	360	22	19·4		113
	2	—	0·5		—	6	3·0		200	31	23·0		135
	3	10	5·1	+	196	87	31·9	+	273	381	246·0	+	155
	4	1	5·3		19	92	33·5	+	275	460	258·5	+	178
1950	1	—	0·8		—	10	5·2	+	192	49	40·1		122
	2	—	1·2		—	7	7·3		96	58	56·4		103
	3	4	8·4		48	181	52·9	+	342	347	407·9	−	85
	4	1	3·8		26	106	24·0	+	442	128	184·6	−	69

*This is an arbitrary selection to show the method. The full table, comprising 83 County Boroughs and 62 Administrative Counties, may be consulted at the General Register Office on request, and may possibly be published later in an Annual Statistical Review of the Registrar-General.

This is less than the number actually observed but not significantly so. For the administrative counties we have seven observed occurrences, while the expected occurrences amount to:

$$248\left(\frac{24}{248}\times\frac{52}{248}\right)=5.$$

The expectation is associated with a standard error of sampling of 2·2, so that the excess is again not statistically significant. If we take combinations of excess prevalence in the first quarter with excess prevalence in either the third *or* the fourth quarter (or both) we obtain this result:

Region	Coincidences	
	Observed	Expected
County Boroughs	6	3·9 ± 2·0
Administrative Counties ..	11	7·5 ± 2·7

On the assumption that incidence in the winter is entirely independent of that in the ensuing summer, the expected coincidences are small in number and are fewer than those actually observed, though not by statistically significant margins. The observed coincidences were still very small. In the total of 43 instances of high prevalence in the winter,

excessive summer or autumn prevalence followed on only seventeen occasions.

The combination of high prevalence in winter with high prevalence in the ensuing summer observed in Bristol and Birmingham was not a commonly observed phenomenon suggestive of an epidemiological law; high prevalence in winter cannot be presumed to have any general prognostic value.

It might be thought that our test of major prevalence is too stringent, since it depends on excess above average and does not therefore admit the possibility of epidemics of large and equal proportions in every area at the same time (there would then be major prevalence without any plus or minus signs). This last event has not yet occurred. In the full tabulation of which Table V is a sample there were many plus and minus signs. Furthermore, for a prognostic sign to be of value, it must not merely warn of *some* epidemicity in the summer since that is expected by every Medical Officer of Health; it must warn of exceptionally high prevalence. On these grounds the stringency appears justified.

Periodicity of High Prevalence

For England and Wales *as a whole* 1947, 1949, and 1950 were each years of epidemic prevalence with numbers of cases far exceeding the pre-1947 figures. The tabulation of which Table V is a sample showed the extent to which this was true of individual areas. If we regard prevalence as "high", "average", or "low", according to whether there is a plus, nil, or minus against the third or fourth quarters, we obtain the following picture for those areas which had more than one "high" year in the period (towns with three "high" years, *i.e.* two intervals, are counted twice):

Interval (yrs) between Two "High" Years	County Boroughs	Administrative Counties
1	16	15
2	6	10
3	3	4
Total Intervals ..	25	29

Only 21 out of 83 towns and 22 out of 62 counties experienced more than one "high" year, but in these areas the two "high" years often succeeded each other.

The nature of the prevalence in the year following a "high" year can be indicated thus:

Prevalence in Year following "High" Year	County Borough	Administrative Counties
High	16	15
Average	25	26
Low	11	10
Total	52	51

The year following a year of high prevalence is more often "high" or "average" than "low". It is clear from this that local areas cannot be assured of any respite following a major outbreak. It appears that in areas which have so far been subjected to epidemic prevalence in excess of the average the "susceptibles" are not exhausted in the single seasonal outbreak; often sufficient escape to support a major prevalence when conditions once more favour epidemicity (Bradley and Richmond, 1953).

The prevalence following "low" years is indicated below:

Prevalence following "Low" Year	County Boroughs	Administrative Counties
High	15	13
Average	38	22
Low	19	10
Total	72	45

In the year following low prevalence "high" and "low" prevalence are almost equally likely, but "average" prevalence is most frequent. Subnormal incidence in one year is therefore not a sure indication that epidemicity will be maximal in the following year.

In the limited experience reviewed here, there have been towns with successive "high" years and towns with successive "low" years, but it is uncommon for "high" and "low" years to occur equally in the same town. The result has been, as indicated in the early part of this paper, an uneven distribution of prevalence of poliomyelitis during the period 1947 to 1950. It remains to be seen whether this experience will be maintained or whether time will level out differences.

Summary

An examination has been made of the geographical variation in the incidence of notified poliomyelitis in England and Wales during 1947 to 1950. There has been a tendency for some areas to suffer successions of years with higher than average prevalence, and for other areas to experience successive years with lower than average prevalence; on balance there are some areas of the country which within the period studied had significantly higher prevalence than others. This differential incidence does not appear to be associated with social conditions as measured by the proportion employed in unskilled occupations or housing density. The notifications in the County of London were examined to see whether there was any occupational factor in the transmission of the virus. The results were negative.

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P-TECHNIQUE

A NEW STATISTICAL DEVICE FOR ANALYSING FUNCTIONAL UNITIES IN THE INTACT ORGANISM

BY

RAYMOND B. CATTELL and HENRIETTA F. V. M. WILLIAMS

Psychology Department, University of Illinois

(1) Place of P-technique in Scientific Method

The methods of science lie in a continuum, at one end of which is complete experimental control, in which all significant conditions beyond those of the independent variable are held constant while changes in a dependent variable are related to controlled changes in the independent variable. This we may call the classical experimental method of the physical sciences. At the other end of the continuum we have the experimental design, in which practically nothing is controlled or controllable, but in which observations are made on a number of variables representing natural processes which occur in the organism *in situ*.

Biological sciences have, in the main, made great efforts to imitate the physical sciences by using, wherever possible, the classical, controlled experiment. However, this has naturally been done at the cost of neglecting a number of important problems involving the total organism in its natural setting, and and often by resort to very awkward experimental arrangements. Physiology, as well as psychology and the social sciences, is faced with the problem of finding interrelationships among variables in a complex situation. In physiology, this complex situation is the organism or even one organ, with its many variables influencing each other in some way. The controlled classical experiment ignores these complex relationships, and, by its very nature, can clarify certain relationships only under very specific conditions.

Until recently, it was not appreciated that the same problems that were being tackled by such contortions of the classical experimental approach, and often at the cost of working upon "physiological preparations" not strictly comparable with the intact organism, are now capable of being tackled by improved statistical methods aimed at allowing for the influences which could not be controlled, and permitting relations to be analysed while the organism is performing in its natural totality and in its natural environment. Outstanding among these modern statistical methods is the method of factor analysis (Cattell, 1952, Thurstone, 1949). It is the purpose of the present paper to attack the problem of measuring the inter-relationships of several variables in the organism *in situ* by the technique of factor analysis, and to do so by means of a fairly substantial example in experimental research.

Although it is possible to use factor analysis in connection with some degree of experimental control, it is typically used with no control whatever. That is to say, an organism, or even an organ, is measured with respect to, say, twenty or thirty variables, which are believed to be interrelated in some way and which are allowed to vary naturally, *i.e.* under the impact of natural demands. Correlations are then worked out among these measurements. By the method of factor analysis applied to the correlations, it is possible to show, usually, that the functional interconnections are due to a relatively small number of factors, maybe five to ten in the case of thirty or so variables. These factors are underlying influences, or sources of variation, which are responsible for the observed correlations. In the physiological realm, such an underlying influence might be an endocrine substance, a pattern of autonomic innervation, and so on. The factor analytic method is especially potent in bringing out patterns which could only be found by a lengthy series of related researches if variables were taken only two at a time, as is typical of the classical experiment. It also has the special value of being able to deal with the total organism and of isolating, by statistics rather than by experimental dissection, the functional unities which might vanish under physical experimental control.

Factor analysis can be applied in a number of distinctive experimental designs or techniques, of which there are basically three, known as R-, P-, and T-techniques (Cattell, 1952). Only the first two are of importance for physiology. In R-technique one takes a population of say a hundred individuals and measures each on the same thirty variables

involved. The correlations then obtained among the variables depend upon individual differences. That is to say, if individual X is higher in one manifestation of thyroid activity, we should expect him also to be higher in the other measures of thyroid activity, so that correlation of these various activities, along with activities which have nothing to do with the thyroid, would allow the former to stand out from the latter as a pattern of positively correlated variables. This is the commonest form of factor analysis in psychology. More recently, however, a form of factor analysis has been developed, called P-technique (Cattell and others, 1947; Cattell and Luborsky, 1950; Cattell, 1952), which will have more appeal to the physiologist because it deals with the single organism. In this technique, a single person or organism is measured on a number of variables over a hundred days or a hundred occasions separated in time or by experimental conditions. Thus, a correlatable series is obtained for each of the variables involved. For example, one might measure the adrenaline level and glucose concentration in the blood on each of the hundred days, in regard to which a positive correlation would indicate some degree of functional connection.

Some of the goals of this method have already been anticipated by experimental and clinical psychologists in the trend toward measuring many variables simultaneously on one animal instead of a few on many animals. But this move in the direction of "holistic" functional understanding has so far not availed itself of the statistical method—the factor analysis of the single organism—which can objectively discover the functional unities.

Physiological research (Best and Taylor, 1945) has also used repeated measurements of a variable (notably in the work of the haematologists) and has correlated such series, as in the basis of P-technique, but here also it has stopped short of the integration reached by the latter, notable in that it has interfered with the natural interactions by bringing its special stimuli (experimental influences which are grosser than the others), and that it has attempted to interpret the correlations one by one instead of by the global factor analytic method.

It is principally in this latter respect that P-technique transcends anything that can be done with correlations alone. As stated earlier, the question whether one allows the physiological changes to occur spontaneously from occasion to occasion, under the impact of natural adaptive demands, or whether one deliberately introduces stimulus conditions, is a relatively minor matter of design.

Medicine seems to have proceeded on the assumption that, though there are individual differences in the intensity of the particular processes, the same general physiological processes will occur in everyone. This is based on the empirical fact that the same patterns of reaction are observed in different people. P-technique simply extends this approach by making the analysis of what goes on in a particular individual more detailed and exact. However, when it is to be thorough, the generalization as to what will happen in people in general still requires the accumulation of quite a number of P-technique studies. It is for that reason that we have not proceeded very far with basic generalizations from the following data, since we await other P-technique studies with the same variables. The only existing studies in P-technique are those of Cattell and others (1947), Cattell and Luborsky (1950), and Williams (1949), so far using largely psychological variables. The reader may be interested to study these from a methodological point of view or to compare them with the present study in relation to the few physiological variables which were included in them, but the present study is the only one in existence of a primarily physiological nature. Even in this study we have included some psychological variables as a matter of interest, particularly to show the value of the method in psychosomatic studies.

(2) Design of the Experiment and Definition of Variables

Although it is true that any experimental statistical design permits one to look for a law in the relation between certain variables, without entering the experiment with too definite a hypothesis as to what form the law must take, factor analysis is unique in demanding no prior hypothesis and in being automatically productive of a hypothesis. One *may* start with a highly specific hypothesis about the forms and relations of the factors, but this is not necessary. For a pattern of factor loadings —a cluster of variables—suggests immediately something about the nature of a certain influence behind them. This creates the hypothesis by which one enters the next experiment into which some new variable can now be inserted and which may be designed more explicitly to measure the hypothesized influence. But in entering the initial factor analytic study one need not have any more definite a hypothesis than is necessary to choose a set of variables, the relations among which are likely to be of interest, in this case to human physiology.

Thus, in the experiment now to be described, we chose a set of variables primarily on the grounds that they were

(*a*) very varied and representative of many aspects of the organism's functioning,
(*b*) known from physiological research to be measurable with experimental accuracy,
(*c*) already indicated as having some relevance to psychological states,
(*d*) known to vary appreciably from day to day,
(*e*) susceptible to repeated measurement without practice effects or other objections to day-to-day testing.

Furthermore, although this is in one sense a pioneer factorization of the whole psychosomatic field, yet there are partial factorizations, *e.g.* Wenger on the autonomic system (Cattell, 1950), Cureton (1947) on the cardiovascular system, and Cattell and Luborsky (1950) on personality factors in the psychosomatic area, which gave us prior indications of what variables might form the centres of functional clusters. The 36* resulting objective and performance variables, and the 31 psychological behaviour rating variables, were thus in fact carefully chosen to be representative, important, and indicated by exploratory factor analyses.

Tests

The tests were given in the order in which they are presented here (and in Table I) to a normally healthy 23-year-old male graduate student at the university. They were given daily at different hours, to explore fatigue effects, for 110 consecutive days.†

Table I

Range of Scores

No.	Test	Range of Scores
1	Recovery of above-threshold visibility after glare	11–26
2	Blood pressure (mm. Hg)	83–110
3	Pulse pressure (mm. Hg)	19–71
4	Heart rate (beats/min.)	72–106
5	Predicted basal metabolism rate	−3–29
6	*p*H saliva	5·7 –7·3
7	*p*H urine	5·3 –7·3
8	Ratio of pupil to iris	0·3 –0·6
9	Salivation (ml./2 min.)	0·8 –2·7
10	Reaction time to light (sec.)	0·34 –0·94
11	Reaction time to light (ratio)	0·76 –1·23
12	Initial resistance PGR	1–91
13	Frequency of spontaneous PGR deflections	2–35
14	Mean deflection magnitude of PGR (per cent.)	1–31
15	PGR to relaxation (per cent.)	1–14
16	Electric shock endurance	50–310
17	Frequency of urinations	1–9
18	Number of defaecations	0–3
19	Number of cigarettes smoked	2–32
20	Self-rating on stuttering	1–4
21	Number of hours after waking	1–15
22	Number of hours of sleep	6·5 –12·5
23	Red blood cells (million/cu. mm.)	4–6·6
24	White blood cells (thousand/cu. mm.)	4·6 –12·8
25	Differential blood count	
	(*a*) Lymphocytes (per cent.)	10–75
	(*b*) Monocytes (per cent.)	0–12
	(*c*) Polymorphonuclear neutrophils (per cent.)	18–64
	(*d*) Eosinophils (per cent.)	0–9
	(*e*) Basophils (per cent.)	0–3
	(*f*) Stab nuclears (per cent.)	0–20
26	Calcium in blood (mg./100 ml.)	7·16
27	Blood sugar (mg./100 ml.)	80–130
28	Cholinesterase ("Rates" in 0·2 ml.)	0·250– 0·850
29	17-Ketosteroids (mg.)	9·0 –17·5
30	Volume of urine (litres/day)	0·9 – 7·2
31	Specific gravity of urine	1·010– 1·045

*Item 25 in the 31 variables listed below under Tests, and in Table I, has six sub-sections making 36 measures in all.

† It was impossible to obtain measures on all variables, such as glucose and calcium content of the blood, on this one individual for each of the days the tests were run. The number of measurements made on each variable follows immediately after the title of each variable with the notation $N=$.

(1) Recovery of Above-Threshold Visibility after Glare ($N = 107$)*.—The subject looked into a box, in which a photoflood light was shining, for 30 sec. At the end of that period, the photoflood light was turned off and a 5-watt bulb turned on. Simultaneously a screen was dropped which revealed a letter of the alphabet. At the time the 5-watt bulb was turned on and the letter of the alphabet was revealed, a reaction-time clock automatically started and was stopped by the subject pressing a key as soon as he could identify the letter. The score was the number of seconds (measured to the nearest hundredth of a second) before the subject could identify the letter of the alphabet.

(2) Blood Pressure ($N = 48$).—The systolic and diastolic blood pressures were taken both by the cardiometer and by means of the stethoscope while the subject was sitting down. The score was the average of the obtained four figures.

(3) Pulse Pressure ($N = 48$).—The score used was the mean of the two pulse pressures found by using the cardiometer and the stethoscope.

(4) Heart Rate ($N = 110$).—The subject counted the pulse beat for one minute.

(5) Gale's Formula for Predicted Basal Metabolism Rate ($N = 48$).—Gale's formula, B.M.R. = Pulse Pressure + Pulse Rate − 111, was used in calculating the basic metabolic rate (10).

(6) *p*H of Saliva ($N = 108$).—The *p*H of the saliva was measured immediately using a Beckman *p*H meter.

(7) *p*H of Urine ($N = 107$).—The *p*H of fresh urine was measured using a Beckman *p*H meter.

(8) Ratio of Pupil to Iris ($N = 104$).—The subject, always keeping his eyes at a particular spot in the room, was placed in a position so that his right eye was exactly 18 in. from a fluorescent light. This distance was held constant by a wire extending from the base of the lamp, with a loop, where the subject was to place his eye. The blinds were always drawn and the overhead light and the fluorescent light were always on, so that the amount of light present was constant. A moving picture was taken of the eye one minute after the fluorescent light was snapped on. On each day, a picture of the date was also taken, so that after the film was developed, the first picture taken for each day was scored. The score was the ratio of the size of the pupil to the iris.

* Owing to some doubtful readings, etc., having to be rejected, the full series of 110 measurements was not obtained in all cases (and in some variables measures were taken only on alternate days). In these variables the correlation is calculated for a shorter series and in order that the standard error of the coefficient may be properly appreciated we give after each variable the N (population of occasions) on which it is based.

(9) SALIVATION ($N = 108$).—The subject collected all the saliva that he could for a period of 2 min., and at the end of that period it was measured in a tube graduated in 0·2 ml.

(10–11) REACTION TIME TO LIGHT ($N = 110$).—The subject looked into a dark box and was told to tap a key as soon as a photoflood light was flashed on. For the first ten times, he always was given a warning of "Ready" 2 sec. before the light was flashed on. For the last ten trials, however, he was given warnings of "Ready" which varied randomly from 1 to 3 sec. before the light was flashed on. Two scores were obtained from these data: one was the mean reaction time of the total twenty trials; the other was the mean of the first ten trials with regular 2 sec. warnings, divided by the mean of the ten trials with irregular warnings.

(12) PSYCHOGALVANIC SKIN RESPONSE (INITIAL RESISTANCE) ($N = 107$).—A conventional PGR apparatus was used, consisting of a Wheatstone bridge with the hand resistance in series with a recording variable resistance. The subject's right hand was placed on the arm of a chair on which was fastened a leather band. When the leather band was wrapped around the subject's wrist, a zinc electrode came in contact with it just below the palm of the hand. The other zinc electrode, covered with a sponge soaked in a 5 per cent. sodium chloride solution, was applied to the palm of the hand. The PGR initial resistance was taken one minute after the subject was connected to the apparatus. The score taken was the dial reading at that time (Cattell, 1929).

(13) FREQUENCY OF SPONTANEOUS PGR DEFLECTIONS ($N = 107$).—The subject was told to look into a dark box for 3 min. The number of deflections above 5 per cent. of the scale value during the 3 min. interval was recorded as the score.

(14) MEAN MAGNITUDE OF PGR DEFLECTION ($N = 84$).—While the subject remained connected to the PGR apparatus, the following tests were given:

(*a*) He was told to look into a lighted box, at the further end of which was a list consisting of eighteen new words each day. He was told to memorize them by reading the list as many times as possible. One minutes was allowed for this memorization.
(*b*) 15 sec. after the light was turned off in the box, there was a loud noise made by clashing cymbals together three times.
(*c*) During this entire procedure, he had a silver-plated electrode wrapped around his left wrist. In his left hand he was holding another electrode. 30 sec. after the loud noise was heard, he received a severe electric shock.
(*d*) 2 min. 15 sec. after the electric shock was given, the subject was given 90 sec. to recall the words previously memorized.

One PGR score was taken from the above data. This score was the average percentage change (loss) of resistance to the above situations.

(15) PGR MAGNITUDE OF UPWARD DRIFT IN RELAXING ($N = 96$).—The subject was told to relax as much as possible. The score taken was the percentage change (rise) of the resistance.

(16) ENDURANCE OF ELECTRIC SHOCK ($N = 110$).—A low amperage electric current supplied at a constant intermittent rate was delivered to the subject through two electrodes. The voltage was controlled by a rheostat. The subject had both electrodes in the same hand. The voltage of the electric current was gradually increased from zero up to a point where the subject reported that he would endure it no longer. The score taken was the position on the dial at which the subject reported the mounting electric shock was becoming unbearable.

A record was made each day of the number of times the following items occurred after waking until the time of the day the tests were taken.

(17) NUMBER OF URINATIONS ($N = 110$).

(18) NUMBER OF DEFAECATIONS ($N = 110$).

(19) NUMBER OF CIGARETTES SMOKED ($N = 110$).

(20) STUTTERING (a trait of this subject).—A self-rating was made by the subject on the degree of stuttering during the day. The subject rated this on a scale varying from one to four points. If he felt he had stuttered badly during the day, he rated himself as four; if he rated himself as one, he was free of any blocking of speech. He had formerly been classified as a stutterer, but in the 2 years preceding this study was no longer so classified. He reports, however that there are subjective "feelings of stuttering" when he is talking and in a state of tension.

(21) NUMBER OF HOURS AFTER WAKING UNTIL TESTS WERE GIVEN ($N = 110$).

(22) LENGTH OF SLEEP ON PREVIOUS NIGHT ($N=110$).

(23) RED BLOOD CELLS ($N = 92$).—Two red blood cell counts were always made, and at no time during the entire 92 days did the two counts at one occasion vary more than 300,000 red blood cells per c.mm. The score used was the mean between the two determinations.

(24) WHITE BLOOD CELLS ($N = 88$).—Two determinations of white blood cells were made each day and at no time during the 88 determinations did the two counts differ more than 250 white blood cells per c.mm. The score used was the mean of the two determinations.

(25) DIFFERENTIAL BLOOD COUNT ($N = 73$).—This was made using Wright's solution, and the following scores were taken in percentages:

(*a*) *Lymphocytes*
(*b*) *Monocytes*
(*c*) *Polymorphonuclear Neutrophils*
(*d*) *Eosinophils*
(*e*) *Basophils*
(*f*) *Stab Nuclears*

(26) CALCIUM CONTENT OF BLOOD SERUM ($N = 30$).—This was determined by the Clark-Collip method.

(27) GLUCOSE CONTENT OF BLOOD SERUM ($N = 30$).—This was determined by the method of Folin and Wu.

(28) CHOLINESTERASE ($N = 15$).—The procedure described by Alles and Hawes (1940) was followed, except that 50 mg. acetylcholine was used instead of 100 mg. in the substrate. The values obtained are the "Rates" defined by Alles and Hawes (1940) and originally established by Stedman, Stedman, and Easson (1932). The value used was the "rate" of cholinesterase found on 0·2 ml. blood serum.

(29) 17-KETOSTEROIDS ($N = 22$).—A 24-hour sample of urine was collected each day and the 17-ketosteroids measured as described by Todd and Sanford (1939).

(30) VOLUME OF URINE SINCE AWAKENING IN MORNING ($N = 36$).—This was recorded just before the subject retired for the night.

(31) SPECIFIC GRAVITY OF URINE ($N = 36$).

(32) SERIAL NUMBER OF SESSION ($N = 110$).

PSYCHOLOGICAL VARIABLES.—Each day of the 110-day interval, ratings were made on the subject's behaviour after the above objective tests were given.

The subject rated himself on a graphic scale running from 0 to 100 on the following eighteen questions:

(*a*) Do you feel relatively shy and self-conscious to-day, so that you have tended to keep in the background on social occasions?
(*b*) Have you felt to-day that your mind has tended to move slowly so that you keep to one track in conversation instead of jumping about?
(*c*) Have you felt to-day rather easily excited and rattled in difficult situations?
(*d*) Do you feel unduly sensitive so that your feelings are easily hurt by remarks?
(*e*) Have you felt depressed and miserable for no good reason or have you felt above average in spirits?
(*f*) Have you felt unduly worried and tense to-day or not?
(*g*) Have you suffered to-day from periods of loneliness?
(*h*) Is this a day on which everything seems to have gone wrong or on which things go well?
(*i*) Have you been day-dreaming much to-day?
(*j*) Has your memory been good to-day or poor and uncontrolled?
(*k*) Have you felt to-day generally very self confident or lacking in confidence?
(*l*) When things have gone wrong to-day do you think it has been mainly your fault or the fault of others?
(*m*) Have you felt so absorbed in your work to-day that you have not noticed a need for company?
(*n*) Have you been above or below average in your persistence and perseverance to-day?
(*o*) Do you feel that your emotional moods have been under very good control or not?
(*p*) Have you been rather easily startled and distracted by sudden sounds to-day?
(*q*) Did you fall asleep easily last night, or did you suffer from some degree of insomnia?
(*r*) Have you spent much time to-day in serious discussions, or intellectual analysis, or not?

The daily *behaviour* of the subject was also *rated* on a graphic scale, ranging from 0 to 100, on thirteen observer evaluations of the same behaviour as is described in the self ratings listed above. This evaluation was done by two acquaintances, one of them being the experimenter who gave the tests each day.*

Since the correlation coefficients between the ratings from the two acquaintances were positive and large, the rating scores were combined. Those between some of the ratings of corresponding behaviour by the observers and by the subject were also large enough to warrant combination in a single score. After the scores were thus combined in trios there were *nineteen psychological behaviour* scores.†

(3) STATISTICAL ANALYSIS OF DATA

Before describing the factor analysis, one must attend to the statistical properties of the individual measures. Normality of distribution is not essential to correlation, but it is important to know how large the range of scores is and of what magnitude the experimental error of measurement may be. These are of interest for comparison with other physiological experiments, apart from the present statistical analysis. The ranges are set out in Table I and a sample of the reliability coefficients in Table II.

TABLE II

Test	Reliability Coefficient
Dark-adaptation	0·84
Blood Pressure	0·71
*p*H of Saliva	0·93
*p*H of Urine	0·93
Reaction Time to Light	0·76
Red Blood Cells	0·81

The magnitude of experimental error of measurement is properly ascertained by that reliability index which we call the consistency (split-half) coefficient for the coefficient of stability (test-retest) indicates both the inconstancy due to error and that due to function fluctuation. Some physiological research has overlooked this, ascribing the difference between repeat measures of the same thing to error of measurement; but it is actually this true function fluctuation upon which P-technique depends for its discovery of functional unities. Unfortunately the determination of a split-half (consistency) coefficient is not practicable with

* The list of the thirteen items can be found in Williams (1949, 1953).

† The correlation coefficients for the ratings made by the two acquaintances, and those for the ratings made by the acquaintances and the subject can be found in Williams (1949.

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many of our measures and we have had to confine ourselves in Table II to those in which an *immediate* retest of the function could be made on each of the occasions of administration. By the usual standards of reliability of psychological and physiological measurement the values in Table II are good, except for the blood pressure measure, which indicates a moderate experimental error.

All 52 of the physiological and psychological performance measures were intercorrelated in all possible pairs, yielding a total of 1,326 correlations in the correlation matrix.* The three pure behaviour rating variables were not correlated in with this matrix, but their associations were found later by correlating them with the emerging factors.

Naturally, the reader must be referred elsewhere (Cattell, 1952; Thurstone, 1947) for the mathematical presentation of the factor analytic process, but it may be pointed out here that in its simplest form it consists in looking for a number of collections of variables, in each of which all correlations are positive and substantial. That is to say, we look for clusters of variables which "go together" in their day-to-day changes. It is then argued that these variables must be expressive of some single underlying influence, and the nature of the variables gives a hypothesis as to what this influence might be.

In this case, thirteen factors were found necessary to account for the correlations among the 36 physiological variables. No significant residual remained after these thirteen factors were extracted by the multi-group method. As usual, the factors were "rotated" after extraction to find a simple structure, *i.e.* a position of maximum meaning (Cattell, 1952; Thurstone, 1947). After eleven over-all blind rotations, *i.e.* without guidance by physiological pre-conceptions, a definite, unique simple structure was found, in which, as usual, some slight correlations were found to exist among the distinct factors. It is the factors in this final form of which the following descriptions are given.

A more detailed account of the factor extraction is given in Williams (1949), and the full tables for the correlation matrix, the unrotated factor matrix, the transformation matrix, the inter-factor correlation matrix, and the rotated simple-structure matrix are there presented. Here we present the essence only from the latter matrix, in the form of the highest loaded variables found for each factor. The psychological performance variables have been omitted, for the clearer perception of the purely physiological picture, but are discussed systematically elsewhere (Williams, 1953).

*The full Pearsonian formula, $r = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{N\sigma_x\sigma_y}$ was used.

It will be understood that we are not trying to explain *why* or *how* each of the groupings of variables set out in the following section is to be accounted for by a single factor. For some readers, our interpretation of the various factors may not be adequate, and they may have additional hypotheses as to each of the functional unities presented. Where no explanation suggests itself, we shall simply record the pattern. If, with the increase of factor analytic research, the factor is nevertheless confirmed in a later study, the absence of explanation in terms of current concepts will become a serious challenge, pointing to missing hypotheses in current explanations and in existing knowledge of the functions of the organism.

(4) Nature of the Functional Unities

In Table III the four variables in Factor 1 above the 1 per cent. level of significance of correlation with the factor (Saunders' criterion, Cattell, 1952) are set out. Here, as elsewhere, whenever a loading is negative the verbal description of the variable is inverted also, *e.g.* a high ketosteroid concentration is written *low*, for this is the meaning of the negativeness of loading. Incidentally, if we knew the consistency coefficients of all variables, the loadings would be, with advantage, "corrected for attenuation" (Cattell, 1952), which would place them in a slightly different order, but some allowance from general knowledge of consistency can be made mentally in our interpretations.

Table III
FACTOR 1

	Factor Loading	Description of Factor by Loadings
Factor 1	−0·84	Low 17-ketosteroids in urine
	−0·73	Fast reaction time
	−0·44	Small number of red blood cells
	−0·33	Small percentage of polymorphonuclear neutrophils
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 1	−0·81	Good control of memory
	0·80	Feelings not easily hurt; not lonely; everything seems to have gone well; not depressed
	−0·78	Be.ow average in perseverance (Small will effort)
	0·74	Not shy and self-conscious; not daydreaming; sociable
	−0·73	Self confident, absorbed in work
	0·72	Not unduly worried and tense; not anxious or tense
	0·664	Did not keep to one track in conversation

We are probably safe in ruling out a first possibility that Factor 1 is a functional unity present when there is infection, for although Forbes and others (1947) have shown that as little as 30 per cent. of the normal amount of 17-ketosteroids is excreted when there is an acute infection, as in appendicitis, segmented

cells are very few, and, more conspicuously, white blood cells are not numerous.

The small number of red blood cells would indicate that the subject is in an opposite state from one of emotional strain, for many investigators such as Sanford (1943), and Cattell and Luborsky (1950) have pointed out a pattern of emotional polycythaemia.

The outstanding feature of this factor is its very high correlation with those psychological rating variables which are consistent in indicating confidence, good command of memory, self-sufficiency, and freedom from anxiety.

Our hypothesis will be that this factor corresponds in its positive direction, to a state of being well rested, with large unused physiological reserves, and, in its opposite direction, (with a *large* ketosteroid excretion, slowed reaction time, anxiety, will effort, poor memory and loss of confidence) to that state of stress *exhaustion* which, Forbes and others (1947), and Selye (1950), have described. If this is correct, it suggests that certain psychological performance measures (Williams, 1949)—notably of reaction time, fluency, and memory—could be combined with the ketosteroid assay to give a more accurate measure of stress exhaustion.

Factor 2 (Table IV) shows a resemblance to Factor 1 in ketosteroid association and some psychological ratings, though the two are nevertheless independent. This example reminds us that one variable may appear in several factors—up to the point when its variance is wholly accounted for, *i.e.* when the sum of the squares of the loadings equals one. This is likewise generally understood in physiological as in statistical terms. For example, we know that a large number of red blood cells might indicate an emotional state, a condition of muscular exercise, haemorrhage, carbon monoxide poisoning, change of climate, a particular diet, etc. In interpreting the presence of a single variable, therefore, we must take the causal explanation indicated by the background of the other variables also found to load the factor under consideration.

As pointed out in Factor 1, Forbes and others (1947) noted that the excretion of 17-ketosteroids is increased when the organism is responding to an emergency such as burns and non-infective surgery. But physiological emergency does not seem to be indicated in Factor 2 in the same way as Factor 1 because of the absence of several physiological variables which one would expect to be present if this were true. Tod and Jones (1937) and Richter and Lee (1942) have shown that patients with anxiety states, or normal subjects subjected to severe worry, show a significant increase in serum cholinesterase. The subject was not rated as anxious or worried in this factor, although in another (Factor 5) it is shown that the serum cholinesterase does increase with worry and anxiety.

If this factor is to be regarded physiologically as a stress influence—and the ketosteroid, cholinesterase, and acid saliva would indicate this—it may be different from the other two stress factors (Factor 1 above and Factor 5) in arising from a high degree of willed, effortful activity imposed by a conscientious, persistent "mood" in the subject.

Factor 3 (Table V) shows the general adaptation syndrome described clinically by Selye (1950), and experimentally by Izquierdo and Cannon (1928). The variables are those which rise together in the countershock phase, with the exception of low diuresis, which belongs to the shock phase but would be

TABLE IV
FACTOR 2

	Factor Loading	Description of Factor by Loadings
Factor 2	0·87	High 17-ketosteroids
	0·67	High cholinesterase
	−0·37	Low *p*H of saliva
	−0·32	Low pulse pressure
	0·29	Increased pulse rate
	0·22	Large amount of salivary secretion
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 2	−0·66	Good control of memory
	0·50	Not shy and self conscious; not daydreaming; sociable
	0·49	Did not keep to one track in the conversation; talkative
	−0·48	Not excited and rattled; above average in persistence; emotionally under good control; steady, calm, realistic
	0·47	Adventurous, debonair, high sex and food interests
	0·44	Not sensitive; in high spirits; not lonely, things have gone well; cheerful
	0·43	Not worried and tense; adaptable, easy-going, placid

TABLE V
FACTOR 3

	Factor Loading	Description of Factor by Loadings
Factor 3	−0·71	Low calcium content of blood
	0·55	High blood pressure
	0·52	Lateness of the session in series
	−0·39	Small percentage of lymphocytes
	−0·37	Low pulse pressure
	0·31	High glucose content of blood
	0·31	Large percentage of eosinophils
	−0·31	Small volume of urine
	0·27	High pulse rate
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 3	−0·200	Not self assertive, lacking in confidence; not conceited

recorded here naturally with a time lag. These variables are the raised blood pressure, raised glucose and high pulse rate.

The somewhat puzzling item for such interpretation is the low calcium level. In psychosomatic research *apparently* contradictory findings exist on calcium level. Glaser (1924), Kretschmer and Kruger (Dunbar, 1946), and Tomasson (1924) find high calcium level with "nervous" individuals; but Cattell and Luborsky (1950) find high calcium level in a behaviour factor of relaxation and low reactiveness. It can be objected to the earlier studies that the definition of the psychological variable "nervous" has varied from timidity, through anxiety and neuroticism, to manic irascibility. In the present study two factors are significantly correlated with calcium level, this and Factor 7, and both have the quality of reaction to some stress.

This factor has some slight relation to psychological ratings of "lacking self-confidence". It fits better the high reactivity of the Cattell and Luborsky factor and the notion of general adaptation syndrome. Incidentally high blood pressure is also found here in three factors and the associations previously found thereto by Herrington (1942) we believe belong to another factor. A low urine volume was found by Mohr (1925) to occur with freedom from anxiety states and that also belongs in another factor from the present one. The low lymphocyte count may be most simply interpreted as freedom from some intermittent infection. In that case the stress situation responsible for this pattern is probably indicated by the correlation with "lateness of session" to be the subject's impatience and annoyance with the prolongation of the test sessions.

Factor 4 (Table VI) is the only factor significantly loaded by the time of day. Since the number of cigarettes smoked, number of urinations, and number of defaecations were scored at the time the tests were given, we would expect their number to increase the later in the day the tests were given. The increase in the number of white blood cells also supports this interpretation, for we know that the minimum number of white blood cells occurs in the morning while the maximum number occurs in the evening. This factor shows no correlation with the ratings, except a slight one with the one question rated by the subject on the amount of time spent in serious discussions (again a matter of time passed). This factor is clearly to be interpreted as diurnal fatigue—that fatigue which is a simple function of the number of hours the subject has been awake. Incidentally, for those not having confidence in factor analysis from experience, the fact that the blind statistical process has here picked out and put together just those variables which increase with hour of day is an example of what is meant by the process yielding functional unities.

There is now reasonably reliable evidence that high serum cholinesterase is associated with states of anxiety, Richter and Lee (1942) and Eysenck's studies on individual differences (Cattell, 1950) show it to be associated with desurgent, *i.e.* anxious-depressive, temperaments. However, the problem is one of separating distinct influences on cholinesterase level, for our factorization brings it into three factors, namely Factor 2 (the conscientious effort factor), Factor 5, and Factor 6 below.

The presence in this case of the psychological ratings not present in the others—tense, worried, shy submissive, and paranoid ("fault of others")—indicates that Factor 5 (Table VII) represents the desurgent, anxious-depressive pattern previously found. In agreement with this is the acidity of saliva, previously found with an "overwrought" state (Cattell and others, 1947; Cattell and Luborsky, 1950), and the alkalinity of urine found with

TABLE VI
FACTOR 4

	Factor Loading	Description of Factor by Loadings
Factor 4	0·73	Many hours after waking
	0·68	Large number of cigarettes smoked
	0·62	Large number of urinations
	0·44	Large percentage of eosinophils
	0·41	Large number of defaecations
	0·32	Large number of white blood cells
	0·31	Large ratio of pupil to iris
	−0·30	Small percentage of segmented nuclear cells

*This factor has its signs reversed relative to the original matrix Williams (1949) because it is then easier to interpret.

TABLE VII
FACTOR 5

	Factor Loading	Description of Factor by Loadings
Factor 5	0·78	High cholinesterase
	−0·71	Low pulse pressure
	−0·59	Low predicted basal metabolism rate (Gale's formula)
	−0·42	Low *p*H of saliva*
	0·32	High *p*H of urine
	0·30	Large percentage of stab nuclears
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 5	−0·30	Shy and self-conscious; daydreaming
	−0·25	Submissive, gentle (not confident, not self assertive, not conceited)
	−0·23	Tense, worried; anxious
	0·21	It is the fault of others when things have gone wrong

* The authors are not attempting in the interpretation of any of the factors to mention all previous research results or to give all possible explanations. For example, the high pH of the urine and low pH of the saliva could be the result of the ingestion of $NaHCO_3$ which increases the CO_2 tension in the blood. That theory would not explain the presence of high cholinesterase and low basal metabolism rate (predicted) in this factor. Theories are presented only to throw light on the meaning of the entire factor.

emotional states (Rich, 1928). The whole pattern therefore appears to be that found with the desurgent state of anxiety, depression, agitation, and discouragement.

This pattern in Factor 6 (Table VIII) resembles that recognized through various researches (Cattell, 1950; Cattell and Luborsky, 1950) as one of parasympathetic activity, the markers thereof being the high electrical skin resistance, large PGR response (Freeman and Katzoff, 1942), frequency of urination, and low cholinesterase (Cattell 1950). Darrow and Heath (1932) noted that their subjects with high initial skin resistance show a freedom from depressive and paranoid trends. The only psychological correlation here, though very slight, is also in the direction of freedom from paranoid attitudes. However, the massive loadings here are primarily in physiological variables and indicate a parasympathetic pattern, with indications that future research should extend to considering short recovery of above-threshold visibility after glare, low cholinesterase, and low glucose concentration as integral parts of the pattern.

TABLE VIII
FACTOR 6

	Factor Loading	Description of Factor by Loadings
Factor 6	−0·60	Low cholinesterase
	−0·53	Short recovery of above-threshold visibility after glare
	0·46	Large volume of urine
	0·44	Large magnitude of deflections of PGR
	0·43	High ability to relax (PGR)
	−0·44	Low glucose content of the blood
	0·39	High initial PGR resistance
	−0·29	Low pulse rate
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 6	−0·156	When things have gone wrong, it has been mostly my own fault

The interpretation of Factor 7 (Table IX) is puzzling. The ratings rule out conscious emotionality, such as the glucose figure suggests. A high calcium content of the blood has been found to be concomitant with an increase in the manic state of the individual (Tomasson, 1942), although Cattell and Luborsky (1950) have shown it is sometimes concomitant with relaxation and low reactiveness, which is more in keeping with the present finding. Conceivably the high calcium is associated with a low psychological sensitivity and case of dissociation. Normally this would lead to relaxation, but in states of environmental press it would also lead to insensitive uninhibited manic behaviour. The high self-rating on stuttering, which the subject has often stated he believed to be brought on by tenseness, is not correlated with ratings of tension and anxiety and fits in better with a dissociation theory of stuttering. Perhaps the high glucose content of the blood, high calcium content of the blood, and the large number of lymphocytes indicates that the organism is "pressed" (in Cannon's physiological sense).

TABLE IX
FACTOR 7

	Factor Loading	Description of Factor by Loadings
Factor 7	0·61	High glucose content of the blood
	−0·60	Low percentage of polymorphonuclear neutrophils
	0·52	High calcium content of the blood
	0·51	High self-rating on stuttering
	0·44	Large percentage of lymphocytes
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 7	0·30	Not shy and self-conscious; not day-dreaming; sociable
	−0·29	When things have gone wrong today, it has been mainly my own fault
	−0·27	Self-confident; absorbed in work
	0·25	Not sensitive; in high spirits; not lonely; things have gone well; cheerful
	−0·25	Memory under good control
	−0·22	Not excited; persevering; emotional moods under control; calm, steady
	0·21	Not startled and distracted by sudden sounds

Factor 8 (Table X) resembles one found by Uhlenbruck and Gildemeister (Woodworth, 1938) which they entitled "autonomic reflex". They found a factor which showed a concomitance of PGR deflections and dilation of the pupil. The percentage deflections of PGR, which indicates momentary spurts of activity by means of the sympathetic nervous system, have a relatively low but positive loading in this factor. Factor 8 is also similar to results found by Freeman and Katzoff (1942) and Darrow and Heath (1932) which are indicative of "autonomic activity".

TABLE X
FACTOR 8

	Factor Loading	Description of Factor by Loadings
Factor 8	0·56	High ratio of pupil to iris
	0·50	High initial PGR resistance
	−0·45	Low tolerance to electric shock
	−0·38	Low specific gravity of urine
	0·34	Large deflections of PGR
	−0·31	Small number of red blood cells
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 8	0·25	When things have gone wrong, it was mainly my own fault
	0·22	Adventurous, debonair, high sex and food interests

In Factor 9 (Table XI) the "later sessions" correlation *might* suggest that the later tests were taken after a meal, which might fit the acidity of the saliva and some of the psychological ratings of relaxation. There are resemblances to the pattern of a factor (Cattell, 1946, 1950; Cattell and other, 1947) of easy-going, adaptable cyclothyme behaviour. Contingently, we must leave it either as a pattern of relaxed temperament or as one of relaxation after a meal.

TABLE XI
FACTOR 9

	Factor Loading	Description of Factor by Loadings
Factor 9	−0·80	Low pH of saliva
	−0·56	Short recovery of above-threshold visibility after glare
	−0·36	Low pulse pressure
	0·34	Lateness of session in the series
	0·34	High PGR initial resistance
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 9	0·37	Persevering, conscientious
	−0·33	Not excited; above average in persistence; emotional moods under good control; steady, calm
	0·32	Have not kept to one track in the conversation; talkative
	0·31	Not sensitive; in high spirits; not lonely; things have not gone wrong today; cheerful
	0·26	Not worried and tense; adaptable, easy going, placid
	−0·26	Memory under good control
	0·24	Accommodating, communicative, dependent

In Factor 10 (Table XII) the highest variable is one associated with sympathetic nervous system reactivity and the others are in keeping (Darling, 1940). But since Factor 3 has been thought to represent the general adaptation syndrome (Selye, 1950), we are forced to hypothesize that a limited sympathetic nervous system reaction pattern exists additional to the total syndrome of the general adaptation response. Indeed when contrasted with the sympathetic-adrenergic pattern as set out elsewhere (Cattell, 1950) this lacks the low skin resistance and high pulse pressure.

TABLE XII
FACTOR 10

	Factor Loading	Description of Factor by Loadings
Factor 10	0·31	High ratio of pupil to iris
	−0·30	Small volume of urine
	0·30	High glucose content of blood serum

In a previous study (Cattell and others, 1947) high frequency of PGR responses when unstimulated has been definitely found associated with a fatigue factor. The substantial correlation (0·42) with lack of sleep found in Factor 11 (Table XIII) fits this interpretation, as also does the tolerance of high electric shock. The subject is jaded, and this is perhaps indicated also by the lateness of session correlation, for the subject became increasingly bored, though the observers' ratings are of "shyness" and lacking confidence. The substantial correlation with red blood cell count and with volume of urine seems to indicate some continued sympathetic system response (Selye's "resistance phase"?) but cannot at this point be more precisely interpreted.

TABLE XIII
FACTOR 11

	Factor Loading	Description of Factor by Loadings
Factor 11	0·63	Great endurance of electric shock
	0·53	Large number of red blood cells
	0·52	Large volume of urine
	0·40	Great *frequency* of PGR deflections
	0·30	Lateness in the session series
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 11	0·42	Suffered from some degree of insomnia
	0·26	When things have gone wrong, it has been the fault of others
	0·25	Lacking in self-confidence; not absorbed in work
	−0·22	Daydreaming; shy and self-conscious; self-contained, withdrawn

Using Wilson's index of resistance, the low number of polymorphonuclear neutrophilic leucocytes in Factor 12 (Table XIV, opposite) indicates a low physical resistance to infection.* The large number of stab nuclears indicates a shift to the left of the Arneth index. We know this occurs along with a high total white blood cell count in cases of appendicitis, acute sepsis, etc. The shift to the left in the Arneth index, occurring along with a diminished total white blood cell count is neither low nor high. Perhaps the large percentage of stab nuclears indicates a lowered resistance, although no specific disease was present. This is the only factor which has even a slight correlation with longer sleep (recorded) the previous night.

In Factor 13 (Table XV, opposite) the cigarettes smoked, having no relationship to the number of hours after awakening, may signify a tension or a substitution of smoking for eating, sometimes noted with this subject. Since volume of urine is not one of the items loading this factor, the low specific gravity of urine may fit in with this. The small number of eosinophils would indicate that there is no

* Wilson's formula is as follows: IR = (T–10) (P–20); IR being the "index of resistance", T the total leucocyte count expressed in thousands, and P the polymorpho-neutrophilic percentage. Since the total number of white blood cells is neither large nor small in this factor, we shall assume it is average, *i.e.* 5,000 per cu. mm. Since the average neutrophilic percentage of white blood cells is 60 or 70 per cent. and since it is lower than average in this factor, let us assume the percentage to be 50. Our formula would then be as follows: IR = (5–10) − (50–20) which would give a minus quantity. According to Wilson, a minus quantity indicates a low power of resistance.

TABLE XIV
FACTOR 12

	Factor Loading	Description of Factor by Loadings
Factor 12	0·81	High specific gravity of urine
	−0·40	Small percentage of polymorphonuclear neutrophils
	0·37	Large percentage of stab nuclears
	−0·34	Small percentage of basophils
	−0·33	Small number of eosinophils
	0·17	More sleep than usual previous night
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 12	0·34	Accommodating, communicative, dependent
	−0·32	Not excited, above average in presistence; emotional moods under control; steady, calm, realistic
	0·30	Not sensitive; in good spirits; not lonely; things have gone well; cheerful
	0·29	Persevering, conscientious
	0·28	Not worried and tense; adaptable, easy going, placid,
	0·27	Vigorous, co-operative
	0·26	Mind has not kept to one track in conversation; talkative

TABLE XV
FACTOR 13

	Factor Loading	Description of Factor by Loadings
Factor 13	0·56	Large number of cigarettes smoked
	−0·52	Low specific gravity of urine
	−0·43	Small percentage of eosinophils
	−0·35	Low basal metabolism rate (predicted from Gale's formula)
	Correlation Coefficient	**Interpretation**
Correlation Coefficients of Ratings with Factor 13	−0·22	Stern, solemn, secretive

presence of an allergy or asthma. The low predicted basal metabolism rate indicates a phlegmatic or apathetic state since pulse rate and basal metabolism rate has been shown to be positively related to physical energy (Glaser, 1924). The physiological variables, along with the rating "stern, solemn, secretive", point to some apathy or withdrawal, As usual in factor analytic work, the last two or three factors are the hardest to interpret and should have their uncertain patterns confirmed by repeat studies before more extensive discussion is attempted.

(5) General Discussion

Of the thirteen factors discovered, perhaps a half have sufficient resemblance to known syndromes, previously located factors, or the expected results of processes recognized by present physiological knowledge to "make sense". The remainder can be considered as a challenge to physiological hypothesis formation—a serious challenge if confirmed by another P-technique study—or as a reflection on the soundness of the method. Let us examine the latter possibility and ask in what ways it could be improved.

In the first place, it is likely that research physiologists will be able to suggest from up-to-date hunches certain theoretically important variables, repeatable from day to day, not included in those suggested by our initial survey of the field. Such should certainly be included with the present battery in a follow-up. Secondly, with our psychological prepossessions, we have probably been too optimistic about the fraction of the variance contributed by emotional conditions relative to that arising from physical conditions, and have consequently failed to include sufficient variables defining the latter (it is, with this design, not a question of "holding the latter constant"). Chiefly we are aware, in retrospect and in view of the speculation caused by certain patterns, that we did not include enough information about the subject's food intake and the time relations of the sessions to meal times. Perhaps there should have been closer records also of intercurrent "colds" or other infections.

Apart from the nature of the variables and conditions of their measurement, which can be readily adjusted to further suggestions, there is also a systematic defect in the new method—or, at least, a difficulty in aligning the concepts which emerge from it with those familiar to the physiologist from the classical "controlled experiment" method. In the latter it is easy, and usual, to distinguish, by means of the known time sequence, between causes and effects, *i.e.* independent and dependent variables. In factor analysis all that we have is proof of association (correlation with the same factor) and no indication of which variable is prior. An argument can be made, it is true, for the conclusions that the factor itself (some entity *behind* the correlated variables) is the cause, and that the correlated variables are in the chain of consequences, but this is a complex matter (Cattell, 1952). Without resort to such a solution, we can nevertheless take up the methodological position that factor analysis has its important role as an exploratory device in a poorly structured, chaotic area, and that its aim is to reveal collections of associated variables which immediately suggest hypotheses that can thereafter be investigated more closely by the methods of controlled experiment.

In comparing the results of the present correlation method with those of experiments which use comparison of means or analysis of variance, it must be constantly borne in mind that, whereas the latter is

unaware of what happens to the variance (other than that with which it is directly concerned), the factor analytic specification equation allocates the total variance in a variable to all the factor influences involved. The fact that variable x enters into the pattern of Factor A and has part of its variance determined thereby, does not prevent its also having part of its variance determined by Factors B, C, etc. This is frequently overlooked in isolated experiments with few variables which lead to "explanations" of *the* source of variance in some physiological variables which are necessarily conflicting. Experimental concentration on one role of a variable then often causes its other roles and pattern associations to be overlooked. The total factor analytic approach, with the specification equation (which we have not employed here, as being unnecessarily technical), thus enables one to perceive from the beginning that only a certain fraction of the variable's variance can be attributed to a given cause, whereas the experimental study of two variables at a time would leave one quite in the dark as to where the unaccounted causality lies.

(6) Summary

The correlation of 36 physiological variables and nineteen psychological variables measured on a normal 23-year-old male for 110 successive days has yielded clusters of significant correlation coefficients which indicate that a considerable fraction of the day-to-day variation of measurement is due to fluctuation of unitary underlying functions rather than experimental error of measurement.

Application of factor analysis to the correlations by the method of P-technique shows that the variations can be accounted for by thirteen independent influences. From the nature of the variables highly involved (correlated) with these factors it is possible to make preliminary hypotheses about the nature of each, as follows:

(1) A factor of "Large Physiological Reserves (well rested)"—*vs*—"Exhaustion or Inhibited" marked by large ketosteroid excretion, slowed reaction time, low fluency, anxiety, and lack of confidence.

(2) A factor of "Sustained conscientious effort"—*vs*—"Laxness", the first pole having some fatigue elements as in Factor I above, but otherwise different, by inclusion of high cholinesterase, acid trend in saliva, low pulse pressure, and *positive* psychological performances.

(3) A factor having the patterns of what has been described clinically as the "general adaptation syndrome" (Selye, 1950), and more precisely as counter-shock reaction. The correlations show raised blood pressure, blood glucose, and pulse rate, and inhibition of diuresis. The factor pattern is also marked by significantly lower blood calcium and by a rise in general psychological reactivity.

(4) A regular diurnal variation, or hour-of-day factor, associated principally with increase of white blood cell count.

(5) A factor which extends farther into physiological manifestations the factor of "surgency"—*vs*—"desurgency", already established in psychological variables. This shows that the desurgent pole (anxiety, worry, depression, suspicion) is associated with high serum cholinesterase, acidity of saliva, alkalinity of urine, low pulse pressure, and low predicted basal metabolism rate.

(6) A second pattern with one or two of the elements in five, but considered to be the parasympathetic syndrome showing high electrical skin resistance, low blood sugar, large PGR deflection, much diuresis, low cholinesterase, and short recovery of above-threshold visibility after glare.

(7) A factor, independent of that of the general adaptation syndrome, yet resembling it and considered to be a sympathetic nervous system reactivity, showing high blood sugar, reduction of urine volume, and large ratio of pupil to the iris.

(8) A sleeplessness factor, marked principally by increased red blood cell count and frequency of spontaneous psychogalvanic responses.

Five further factors were found, one connected with high calcium content of the blood, but these are too new to justify hypotheses until confirmed in a second study.

In general, these results show that factor analysis is capable of structuring a wide array of physiological manifestations in a way not possible by any other method. Controlled experiments, however, are desirable if these findings by the exploratory, factor-analytic method are to be followed up to give causal explanation of the associations. They also show substantial relations between the physiological patterns and some of the factor patterns previously recognized in psychological (total behaviour) variables. It is to be hoped that physiologists specializing in particular fields may be able to suggest more detailed explanations for some of these observed correlations.

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WEIGHT OF BANTU BABIES IN THE FIRST 10 DAYS OF LIFE

BY

EVA J. SALBER* and EVELYN BRADSHAW

Institute of Family and Community Health, Durban

The present paper is a preliminary report on the growth of Bantu babies in the first 10 days of life with special reference to the effect of birth rank, sex, and marital status of mother.

Material and Method

All full-term infants (excluding twins) born at McCord's Zulu Hospital, Durban, between June 1, 1950, and January 31, 1951, were weighed daily by one of us (E.J.S.); 598 babies born by normal vertex delivery, who were well during their stay in hospital, were studied. All were breast-fed on an elastic 3-hourly schedule with a night feed. The babies shared their mothers' beds, day and night.

The weighing was carried out on a beam scale, which was checked before the start of the experiment, several times during the course of it, and again at the end. Babies were weighed naked, except for the first few days when they wore a crepe binder of known weight, and weighing started at 9.30 every morning. As babies were born at all times of the day and night, it was impossible for us to weigh them at birth, and this was done by the Sister or staff-nurse in charge of the ward, or by a midwife under her supervision. The babies were washed before weighing.

The daily gain or loss from birth weight was calculated, and means and standard deviations of these differences were worked out for each of the first ten days. The total initial loss was recorded, showing the amount lost until the baby's weight became stationary or began to rise, irrespective of whether there was any subsequent loss. The duration of this initial loss was also recorded. Means and standard deviations of these two measures were calculated for married and unmarried mothers.

* Senior Bursar, Council for Scientific and Industrial Research.

Results

(1) Daily Gain or Loss in Weight.—Table I shows the mean gain or loss from birth weight for each day of life for boys and girls separately and together. It will be seen that there are discrepancies in the number of babies weighed from day to day. A certain number of first-day weights were missed because the time of birth coincided with the time of weighing. There is a marked decrease in numbers from the seventh day because of the departure of the mothers from hospital.

For the whole group, the maximum mean loss occurred on the 3rd day, and amounted to 5·7 oz. (5 per cent. of the mean birth weight of 7·18 lb.). The bulk of this loss occurred in the first 2 days. After the 3rd day they started to gain weight at the rate of over an ounce a day, so that the group had regained birth weight on the 9th day. Most observers agree that babies reach their minimum weight on the 3rd day, and lose 5 to 8 per cent. of their birth weight (Meredith and Brown, 1939; Cole, 1939; Palmer

Table I

MEAN GAIN OR LOSS IN WEIGHT IN THE FIRST 10 DAYS OF LIFE BY SEX

Day	Girls			Boys			Sexes Combined		
	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)
1	258	−2·55	2·48	259	−2·68	2·92	517	−2·61	2·71
2	295	−5·35	3·10	293	−5·57	3·24	589	−5·42	3·20
3	297	−5·59	4·55	298	−5·83	4·53	595	−5·71	4·55
4	294	−4·56	5·75	296	−4·80	5·99	590	−4·68	5·88
5	289	−3·42	6·64	295	−3·42	6·75	584	−3·42	6·70
6	283	−2·51	7·32	290	−2·23	7·20	573	−2·37	7·26
7	247	−1·60	7·97	250	−1·36	7·67	497	−1·48	7·82
8	158	−0·51	8·70	175	−0·25	7·69	333	−0·37	8·19
9	91	+0·56	8·60	99	+1·16	8·05	190	+0·87	8·33
10	32	+2·56	8·03	41	+2·90	8·11	73	+2·75	8·07

and Ciocco, 1945; Parmelee, 1952). Our findings compare favourably with those of other observers.

Table I also shows that for boys and girls the maximum mean loss occurred on the 3rd day. This was 5·6 oz. for the girls and 5·8 oz. for the boys (4·9 and 5 per cent. of the respective mean birth weights of 7·07 lb. for girls and 7·28 lb. for boys). The differences between the daily means for boys and girls were very slight, and none was statistically significant. Both groups regained their birth weight on the 9th day, having grown at almost exactly the same rate. By virtue of their superior birth weight, however, the boys remained heavier than the girls throughout this period. Martin (1931), Kugelmass, Berggren, and Cummings (1933), and Gin (1948), found that boys lost more weight than girls. Griffith and Gittings (1907) found that girls lost more weight but for a shorter time. Our findings agree with those of Meredith and Brown (1939), who found that girls and boys lost the same percentage of birth weight.

The babies were divided into first babies (Rank 1) and later born (Rank 2+). Rank 1 babies lost more weight over a longer period than the Rank 2+ babies, and they gained more slowly; they lost 7·2 oz. in 3 days (6·5 per cent. of the mean birth weight of 6·86 lb.), and gained just less than an ounce a day to regain their birth weight on the 10th day. Rank 2+ babies only lost 5·4 oz. in 2 days (4·6 per cent. of the mean birth weight of 7·28 lb.). They then gained at the rate of nearly 1½ ounces a day to regain their birth weight on the 8th day. (See Table II and Figure.)

The differences in mean loss between the ranks were small for the first 2 days and not statistically significant, but from the 3rd to the 8th day the differences were larger, and were statistically significant. On the 9th day the difference approached significance $\left(\frac{D}{S.E.} : 2{\cdot}6\right)$ and on the 10th day there was very little difference. When the boys and girls were examined separately, these rank differences were found to remain the same (see Appendix I). Meredith and Brown (1939) found the loss to be slightly greater with increasing birth order. Longridge (1905) and Cole (1939) found no difference in the behaviour of first-born and later-born babies. Kugelmass, Berggren, and Cummings (1933) found that first-born infants tended to lose more than siblings, and Griffith and Gittings (1907) state that "in children of primiparae the average loss is greater, the duration of loss is longer and day of regain of birth weight is later than in those of multiparae". Our findings are in exact agreement with those of Griffith and Gittings.

(2) Duration of Loss of Weight.—Although the average duration of loss of weight was 3 days, there was great variation among the individual babies; seven lost no weight and one went on losing for as long as 8 days: 55·6 per cent. lost for 2 days or less, 18·7 per cent. for 4 days or more, and only 25·7 per cent. lost for 3 full days. There was practically no difference between the sexes.

As there were so many unmarried mothers at this hospital (about 32 per cent.), it was decided to examine the effect of marital status on the duration

TABLE II

MEAN GAIN OR LOSS IN WEIGHT IN THE FIRST 10 DAYS OF LIFE BY BIRTH RANK (SEXES COMBINED)

Day	Rank 1			Rank 2+		
	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)
1	135	−2·80	3·22	381	−2·55	2·50
2	150	−5·69	3·48	438	−5·39	3·07
3	152	−7·18	4·78	442	−5·22	4·34
4	151	−7·07	6·13	438	−3·88	5·54
5	149	−6·21	7·11	434	−2·48	6·26
6	145	−5·32	7·53	427	−1·38	6·89
7	133	−4·35	8·17	362	−0·43	7·43
8	101	−3·30	8·61	230	+0·90	7·67
9	72	−1·25	9·16	116	+2·14	7·51
10	27	+2·41	8·09	45	+3·00	8·14

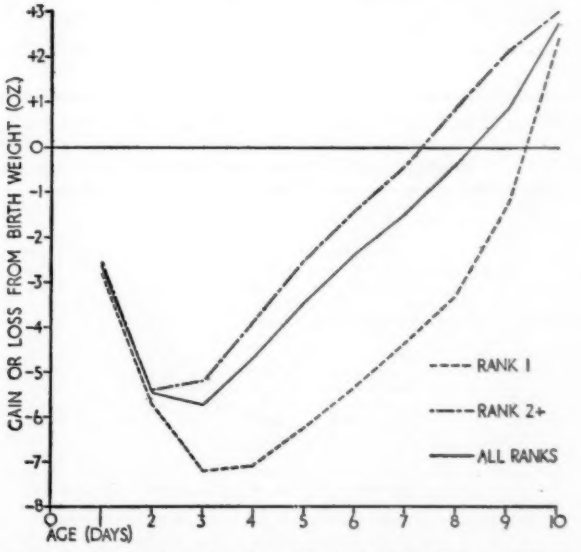

Figure.—Mean gain or loss in weight in the first 10 days of life, by birth rank (sexes combined).

of loss of weight. Table III shows the mean duration of loss for married and unmarried mothers, and also the effect of sex and rank. The mean duration of loss for the total group was 3·15 days.

In no case was a significant difference found between married and unmarried mothers, although in most cases the babies of unmarried mothers lost for slightly longer than those of married mothers. The difference between boys and girls was not significant, although the girls lost for slightly longer than the boys. However, the Rank 1 babies lost for a significantly longer time than the Rank 2+ babies, and this was seen more clearly in the boys.

Griffiths and Gittings (1907), Meredith and Brown (1939), and Parmelee (1952) all emphasize the variation in duration of weight loss in individual babies. Meredith and Brown's findings are in agreement with ours as regards sex, but they found very little difference associated with rank. The findings of Griffith and Gittings agree with ours in regard to rank, but in their series the girls lost for a shorter time.

(3) TOTAL INITIAL LOSS.—It has been shown above that the maximum mean loss occurred on the 3rd day, but that because the duration of loss was so variable only 26 per cent. of the babies reached their minimum weight on that day. It was necessary therefore, to examine the mean amount of weight lost, regardless of when this occurred. Sex, rank, and marital status were taken into account. The results are shown in Table IV. The total initial loss ranged from 0 to 27 oz. (mean of 7·47 oz., 6·5 per cent. of body weight), and the percentage of weight loss remained constant for boys and girls. No significant difference could be related to marital status, or to sex. However, a marked difference was again found between babies of Rank 1 and Rank 2+; Rank 1 lost significantly more weight than Rank 2+ (8·2 per cent. of body weight as against 5·9 per cent.).

This weight loss is lower than that reported by

TABLE III

DURATION OF LOSS OF WEIGHT, BY SEX, BIRTH RANK, AND MARITAL STATUS OF MOTHER

Sex	Marital Status of Mother	Rank 1			Rank 2+			All Ranks		
		No.	Mean (days)	S.D. (days)	No.	Mean (days)	S.D. (days)	No.	Mean (days)	S.D. (days)
Girls	Married	35	3·44	1·55	176	3·07	1·24	211	3·13	1·30
	Unmarried	38	3·82	1·58	45	3·08	1·18	83	3·42	1·42
	Total	74	3·64	1·56	222	3·07	1·22	296	3·21	1·34
Boys	Married	33	3·80	1·40	152	2·87	0·87	185	3·04	1·05
	Unmarried	44	3·41	1·18	67	3·08	1·14	111	3·21	1·17
	Total	78	3·56	1·29	221	2·93	0·96	299	3·10	1·09
Sexes Combined	Married	68	3·62	1·49	328	2·98	1·09	396	3·09	1·19
	Unmarried	82	3·60	1·39	112	3·08	1·16	194	3·30	1·29
	Total	152	3·60	1·43	443	3·00	1·10	595	3·15	1·22

TABLE IV

TOTAL INITIAL LOSS OF WEIGHT, BY SEX, BIRTH RANK, AND MARITAL STATUS OF MOTHER

Sex	Marital Status of Mother	Rank 1			Rank 2+			All Ranks		
		No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)
Girls	Married	35	7·84	4·86	176	6·86	4·06	211	7·02	4·22
	Unmarried	38	8·79	5·41	45	7·59	5·16	83	8·14	5·31
	Total	74	8·28	5·16	222	7·03	4·32	296	7·34	4·58
Boys	Married	33	10·23	6·18	151	6·69	3·85	184	7·32	4·56
	Unmarried	44	9·52	5·61	67	7·22	4·56	111	8·13	5·13
	Total	78	9·78	5·85	220	6·83	4·08	298	7·60	4·79
Sexes Combined	Married	68	9·00	5·66	327	6·78	3·96	395	7·16	4·39
	Unmarried	82	8·18	5·53	112	7·37	4·81	194	8·13	5·21
	Total	152	9·05	5·57	442	6·93	4·20	594	7·47	4·69

Meredith and Brown (1939), Ramsey and Alley (1918), Tyson (1928), and Griffith and Gittings (1907). The two last-mentioned found the loss to be greater in girls than in boys, but Meredith and Brown found no difference. Our findings with regard to rank differ from those of Tyson and Meredith and Brown, who found weight loss to be greater in the higher birth ranks.

(4) RETURN TO BIRTH WEIGHT.—By the 7th day, 17 per cent. of the babies had already left hospital, and by the 10th day only 12 per cent. still remained.

By the 7th day the percentage who had regained or exceeded their birth weight was 47·7 per cent. (Table V). The figure is significantly greater for Rank 2+ than for Rank 1 (52 per cent. as against 34 per cent.). The slight differences between boys and girls are not significant.

TABLE V

PERCENTAGE OF BABIES WHO REGAINED OR EXCEEDED THEIR BIRTH WEIGHT BY THE SEVENTH DAY, BY SEX AND BIRTH RANK

Sex	Rank 1		Rank 2+		All Ranks	
	No. of Cases	Per-centage	No. of Cases	Per-centage	No. of Cases	Per-centage
Girls ..	74	33·8	224	49·6	298	45·6
Boys ..	78	34·6	220	55·0	298	49·7
Sexes Combined	152	34·2	444	52·3	596	47·7

This figure (47·7 per cent.) underestimates the true position, as babies leaving hospital on the 4th, 5th, and 6th days whilst still under birth weight, were included as not having regained their birth weight by the 7th day, although they might well have done so. By the method employed in survival tables, a cumulative percentage of those regaining birth weight each day was calculated for sexes and ranks separately and combined (Table VI). By this method 49·2 per cent. of the babies are shown to have regained their birth weight by the 7th day, and 65·1 per cent. by the 10th day. Again, there is no sex difference when the ranks are combined, although the girls do slightly better in Rank 1, and the boys are a little ahead in Rank 2+. There is a marked difference between the ranks, 49·7 per cent. of Rank 1 and 70·8 per cent. of Rank 2+ regaining their birth weight by the 10th day.

It has been generally accepted by most observers that babies regain their birth weight between 10 and 14 days after birth (Parmelee, 1952). Palmer and Ciocco (1945) state that about 25 per cent. of infants regain their birth weight by the 7th day, and 50 per cent. by the 10th day. This is confirmed by the work of Griffith and Gittings (1907), Ramsey and Alley (1918), Meredith and Brown (1939), and Chalmers (1952). Illingworth and others (1952) reported that 49 per cent. of babies on "self-demand" feeding had regained their birth weight on the 9th day, as compared with 36 per cent. of babies fed on a rigid 4-hourly schedule. Our figure of 59 per cent. on the 9th day compares very favourably with Illingworth's "demand" group, and is better than those of other series previously reported.

Both Griffith and Gittings and Meredith and Brown found little difference between boys and girls in this respect and our findings are similar. Meredith and Brown found a tendency for first-born infants to regain birth weight earlier, while Griffith and Gittings found the opposite. We found a significant difference between Rank 1 and Rank 2+.

TABLE VI

CUMULATIVE PERCENTAGE OF BABIES REGAINING THEIR BIRTH WEIGHT EACH DAY, BY SEX AND BIRTH RANK

Day	Girls			Boys			Sexes Combined		
	Rank 1	Rank 2+	All Ranks	Rank 1	Rank 2+	All Ranks	Rank 1	Rank 2+	All Ranks
1	1·4	1·8	1·7	1·3	0·5	0·7	1·3	1·1	1·2
2	1·4	3·2	2·7	3·9	2·3	2·7	2·6	2·7	2·7
3	10·9	12·1	11·7	6·5	10·0	9·1	8·5	11·1	10·4
4	14·9	24·6	22·1	11·7	24·1	20·9	13·2	24·3	21·5
5	19·0	36·9	32·4	22·1	41·9	36·7	20·6	39·3	34·5
6	27·5	44·8	40·4	28·7	51·1	45·2	28·1	47·9	42·8
7	35·2	51·4	47·3	36·1	56·5	51·1	35·6	53·9	49·2
8	42·1	57·6	53·6	36·1	61·7	54·9	38·6	59·8	54·2
9	49·8	63·7	60·1	38·7	65·2	58·7	44·7	64·6	59·3
10	49·8	67·7	64·5	44·3	73·9	65·2	49·7	70·8	65·1

Comment

We should like to emphasize both the similarities and the differences displayed by our Bantu group as compared with previous studies. Like all other babies, these lost weight for the first 3 days after birth, and then started to gain. The difference here is that their loss falls at the lower limit of the accepted range of loss, and their rate of gain is very much faster, so that a far greater percentage regain their birth weight by the 7th and 10th days than those previously reported. There is, also, the unequivocal superiority of the second and later-born over the first-born. Although this group of Bantu mothers may be on a slightly higher economic level than the general Bantu population, in that they were able to afford the small hospital charges, their general economic level was still very low. A striking feature, however, of Bantu mothers, including this group, is their abundance of breast-milk, their complete acceptance of breast-feeding, and the ease with which lactation is established, and maintained. The accepted Bantu method of breast-feeding, outside the hospitals, is by self-demand. Although this method could not be completely followed in hospital, owing to the 3-hourly routine, the babies shared their mothers' beds, and it was observed that they were fed at other times, particularly at night.

Summary

598 healthy breast-fed babies were studied at McCord's Zulu Hospital in Durban for the first 10 days of life. They were all full-term, single births, of normal vertex delivery. They shared their mothers' beds, and were fed on an elastic 3-hourly schedule with a night feed.

(1) The maximum mean loss of weight occurred on the 3rd day after birth and amounted to 5·7 oz. (5·0 per cent. of the mean birth weight of 7·18 lb.).

(2) After the 3rd day they started to gain weight at a rate of over an ounce a day, so that they had regained birth weight on the 9th day.

(3) No difference was found between boys and girls.

(4) Rank 1 babies lost for 3 days, and regained their birth weight by the 10th day. Rank 2+ babies lost for 2 days only, lost less weight, and regained their birth weight by the 8th day.

(5) There was great individual variation in the duration of loss of weight (0–8 days, mean 3·15). There was no difference between boys and girls, but Rank 1 babies lost for a significantly longer time than Rank 2+ babies.

(6) The total initial loss, irrespective of the day the minimum weight was reached, ranged from 0–27 oz. (mean 7·47 oz., 6·5 per cent. of birth weight). There was no difference between the sexes, but Rank 1 lost 8·2 per cent. of birth weight as against 5·9 per cent. for Rank 2+.

(7) The marital status of the mothers appeared to have no effect on either duration or amount of loss.

(8) By the method employed in survival tables it was found that 49·2 per cent. regained birth weight by the 7th day, and 65·1 per cent. by the 10th day. No difference was found in sex, but 70·8 per cent. of Rank 2+ babies as opposed to 49·7 per cent. of Rank 1 babies had regained their birth weight by the 10th day.

It is thought that the excellence of Bantu mothers as breast-feeders and their method of breast-feeding account for the good progress made by the babies.

We wish to thank Dr. S. L. Kark, Medical Officer-in-Charge, Institute of Family and Community Health, for his continued interest and advice, Dr. Alan Taylor, superintendent of McCord's Zulu Hospital, for allowing us to conduct this investigation, the matron and staff of the hospital for their unfailing kindness and co-operation, and Mr. L. V. Bradshaw for drawing the chart.

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APPENDIX

DAILY GAIN OR LOSS OF WEIGHT IN THE FIRST 10 DAYS OF LIFE, BY SEX AND BIRTH RANK

Day	Girls						Boys					
	Rank 1			Rank 2+			Rank 1			Rank 2+		
	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)	No.	Mean (oz.)	S.D. (oz.)
1	65	−2·55	2·34	193	−2·55	2·52	70	−3·01	3·84	188	−2·56	2·48
2	73	−5·14	2·70	222	−5·42	3·22	77	−6·30	3·91	216	−5·36	2·92
3	74	−6·49	4·56	223	−5·30	4·51	78	−7·85	4·89	219	−5·15	4·16
4	74	−6·43	6·01	220	−3·93	5·52	77	−7·68	6·17	218	−3·83	5·57
5	72	−5·69	6·82	217	−2·67	6·41	77	−6·69	7·34	217	−2·30	6·11
6	70	−4·86	7·54	213	−1·72	7·09	75	−5·72	7·52	204	−0·95	6·82
7	63	−4·40	8·14	183	−0·62	7·69	70	−4·31	8·20	179	−0·24	7·15
8	44	−3·27	9·33	113	+0·61	8·22	57	−3·32	8·01	117	+1·19	7·08
9	31	−1·13	10·22	59	+1·47	7·54	41	−1·34	8·27	57	+2·82	7·42
10	9	—	—	22	+0·73	8·56	18	—	—	23	+5·17	7·08

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PERIOD BETWEEN OVULATION AND BIRTH

BY

J. R. GIBSON and T. DOUGRAY

From the Department of Social Medicine, University of Birmingham, and St. Chad's Hospital, Birmingham

Because dates of coitus, ovulation, and fertilization are usually unknown, examination of the duration of gestation in a large series of women is necessarily based on the period of amenorrhoea from onset of menstruation to birth. The considerable variation in this period is due partly to variation in the interval between onset of menstruation and ovulation, and partly to variation in the time between ovulation and birth. In this communication we examine the period between ovulation and birth, which has been estimated for each of 763 women by:

(*a*) using information about mean length of cycle to estimate the interval between onset of menstruation and ovulation,
(*b*) subtracting this interval from the period of amenorrhoea.

Material and Methods

The period of amenorrhoea (from onset of menstruation to birth) and a menstrual history during the year after birth, were recorded for all mothers domiciled in the County Borough of Smethwick whose children were born between April 1, 1949, and March 31, 1950. To exclude some pregnancies of abnormal duration, the examination which follows is restricted to 1,227 mothers of single births which survived at least until the end of the first year.

Period of Amenorrhoea.—Date of onset of the last menstrual period preceding pregnancy was obtained if it was known at the first ante-natal attendance, and date of birth was later extracted from the records of notification of birth submitted to the public health department. For 108 of the 1,227 mothers the period of amenorrhoea was unknown.

Mean Length of Cycle.—Either on leaving hospital, or at the first home visit by a health visitor, mothers were given a calendar on which they were asked to cross off each day of bleeding during the year after the birth of the child. This calendar was printed on a child's record card on which were entered other items of more interest to the mother, such as the weight of the child. Mothers were subsequently interviewed at a Welfare Centre or at home within 2 weeks of each quarter during the year following birth, when the menstrual history was copied on to another document. These documents provided the data used in the analysis which follows.

In another report (McKeown, Gibson, and Dougray 1953) based on the same data, mean length of cycle was estimated in women for whom at least three cycles were recorded in the year after birth by

(*a*) Excluding women whose cycles were judged on inspection to be irregular,
(*b*) Excluding from the remaining histories occasional cycles whose lengths were inconsistent with the other observations.

Some such procedure is necessary if mean length of cycle is to be given for individual women. For the present purpose we have used a different system of exclusion, which, although more cumbersome and probably not more accurate, has the merit of being objective. The procedure is as follows:

(*a*) Exclusion of 351 women (of 1,119 of known period of amenorrhoea) for whom fewer than five cycles were recorded.
(*b*) Omission of cycles of less than 16 or more than 40 days from records of the 768 women with at least five recorded cycles.
(*c*) Estimation for each woman of crude mean length of the remaining cycles.
(*d*) Omission of cycles more than seven days above or below the crude mean.
(*e*) Exclusion of the five women who had fewer than three cycles (after (*a*)–(*d*)).
(*f*) Estimation of mean length of the remaining cycles for each of 763 women.

It should perhaps be made clear that this somewhat elaborate procedure is not intended to give means which can be regarded as representative of a group of parous women; it is merely designed to give means in that selected group of women whose cycles are sufficiently regular to make estimates of their mean length of any value.

Period Between Ovulation and Birth

(*a*) Variability.—There is a good deal of evidence which suggests that the length of the post-ovulatory phase is fairly constant, being about 14 days, and that variation in length of cycle is mainly due to variation in the pre-ovulatory phase. The interval between onset of menstruation and ovulation has therefore been estimated for each of 763 women by subtracting 14 days from the mean length of cycle, and the period between ovulation and birth was obtained by subtracting the interval between onset

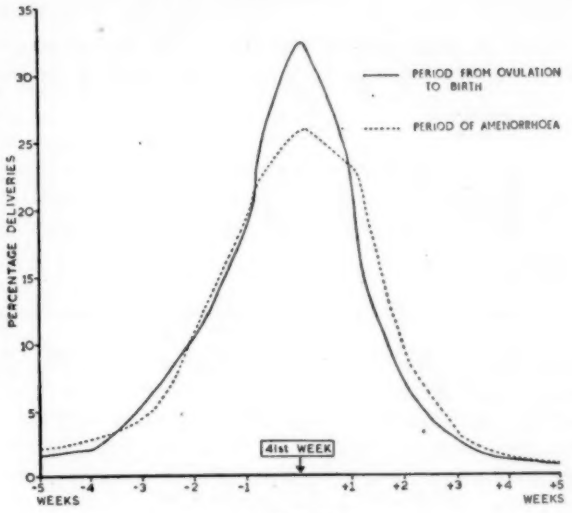
of menstruation and ovulation from the period of amenorrhoea.

Table I compares the distributions of the period between ovulation and birth estimated for 763 pregnancies, and the period of amenorrhoea recorded for 1,119 pregnancies (before exclusion of cases referred to above): the means (in days) are 265·6 and 280·5 respectively. The most obvious result of removing variation attributable to the interval between menstruation and ovulation is an increase (from 25·8 to 31·7 per cent.) in the proportion of cases delivered in what corresponds to the 41st week of amenorrhoea. But there is still considerable variation in the period between ovulation and birth(Figure).

TABLE I
PERIOD BETWEEN OVULATION AND BIRTH

Period of Amenorrhoea (days)	Number of Cases	Per cent.	Estimated* Period from Ovulation to Birth (days)	Number of Cases	Per cent.
217–223	3	0·26	203–209	2	0·26
224–230	3	0·26	210–216	2	0·26
231–237	7	0·62	217–223	3	0·39
238–244	8	0·71	224–230	9	1·18
245–251	18	1·61	231–237	10	1·31
252–258	28	2·50	238–244	13	1·70
259–265	45	4·02	245–251	43	5·63
266–272	124	11·08	252–258	89	11·66
273–279	225	20·11	259–265	148	19·40
280–286	289	25·82	266–272	242	31·72
287–293	248	22·16	273–279	134	17·56
294–300	84	7·51	280–286	48	6·29
301–307	21	1·88	287–293	11	1·44
308–314	8	0·71	294–300	5	0·66
315–321	4	0·36	301–307	2	0·26
322 and over	4	0·36	308–314	2	0·26
Numbers	1,119	100	—	763	100
Mean	280·5	—	—	265·6	—
Error of Mean	0·40	—	—	0·46	—
Standard Deviation	13·5 ±0·3	—	—	12·8 ±0·3	—

*Method of estimation described in text.



FIGURE

(*b*) RELATION TO MATERNAL AGE AND BIRTH ORDER.—It has been shown that there are slight negative correlations between period of amenorrhoea and maternal age, and between period of amenorrhoea and parity (Karn and Penrose, 1951). It is possible, however, that these correlations are due to association of the interval between onset of menstruation and ovulation with age and parity. Indeed Gunn, Jenkin, and Gunn (1937) reported that the length of the menstrual cycle decreased with age, and it seems reasonable to suppose that it is the pre-ovulatory phase which is mainly affected. So far as we are aware the association between length of cycle and parity has not been examined.

The relation of the mean period between ovulation and birth to parity and to maternal age is shown in Tables II and III respectively; there is no consistent

TABLE II
MEAN PERIOD FROM OVULATION TO BIRTH RELATED TO PARITY

Parity	1	2	3	4
Number of Pregnancies	312	239	113	99
Mean Period (days)	265·9±0·71	265·2±0·77	264·0±1·43	267·4±1·23
Standard Deviation	12·60	11·92	15·25	12·21

TABLE III
MEAN PERIOD FROM OVULATION TO BIRTH RELATED TO MATERNAL AGE

Maternal Age (years)	24 and under	25–29	30–34	35 and over
Number of Pregnancies†	230	267	168	97
Mean Period (days)	265·5±0·79	265·4±0·84	266·2±0·92	265·2±1·38
Standard Deviation	12·04	13·79	11·88	13·59

† In one case age was unspecified.

TABLE IV

CORRELATION BETWEEN PERIOD OF AMENORRHOEA AND PARITY AND MATERNAL AGE

Correlation Between	Sex of Child	Correlation Coefficient	Correlation Coefficient Corrected for:				
			Maternal Age	Parity	Length of Cycle	Age and Length of Cycle	Parity and Length of Cycle
Period of Amenorrhoea and Parity	Male	−0·040	−0·029	—	−0·031	−0·030	—
	Female	−0·042	−0·034	—	−0·025	−0·028	—
Period of Amenorrhoea and Maternal Age	Male	−0·030	—	−0·011	−0·008	—	+0·008
	Female	−0·025	—	−0·002	+0·002	—	+0·016

association. But the slight negative correlations would not be expected to be apparent from the means. An alternative method of enquiring whether the association of the period of amenorrhoea with age and parity is due to the interval preceding or following ovulation, is to examine the correlation between period of amenorrhoea and each of the variables, fixing length of cycle.

The correlations are given in Table IV. There are small negative correlations between period of amenorrhoea and parity (males, −0·040; females, −0·042), and between period of amenorrhoea and maternal age (males, −0·030; females, −0·025). The correlation with parity appears to be independent of both maternal age and length of cycle, for it is present when corrected for both these variables (males, −0·030; females, −0·028). But there is a slight positive correlation between the period of amenorrhoea and maternal age when parity and length of cycle are fixed (males, +0·008; females, +0·016). The negative correlation between period of amenorrhoea and age before correction for length of cycle and parity appears to be due to:

(*a*) a negative association (males, −0·202; females, −0·159) between length of cycle and age, the period of amenorrhoea and length of cycle being positively correlated (males, +0·105; females, +0·167)

(*b*) a positive association between maternal age and parity (males, +0·489; females, +0·523), period of amenorrhoea and parity being negatively correlated (as noted above).

SUMMARY

The period between ovulation and birth has been estimated for each of 763 women by:

(*a*) using information about mean length of cycle to estimate the interval between onset of menstruation and ovulation,

(*b*) subtracting this interval from the period of amenorrhoea.

It is shown that the period between ovulation and birth is somewhat less variable than the period of amenorrhoea, percentages of deliveries during what corresponds to the 41st week of amenorrhoea being 31·7 per cent. and 25·8 per cent. respectively. It is also noted that a small negative correlation between period of amenorrhoea and parity is independent of both length of cycle and maternal age, but there is a very small positive correlation between period of amenorrhoea and maternal age when length of cycle and parity are held constant.

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